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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

SECRETARY'S OFFICE, BIRMINGHAM, CONN., Feb. 4, 1891.

To the Members of the New England Association of Gas Engineers:—

The meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, Mass., on Feb. 18 and 19, 1891. The meeting will be called to order by the President, Mr. C. F. Prichard, on Wednesday, at 10 o'clock A.M.

It is hoped that all the members who can possibly attend will be present.

The following papers have been promised:

"Different Methods and Devices for Accomplishing Similar Ends," by H. A. Allyn.

"Note Books: Their Value, and how to Keep Them," by C. D. Lamson.

"Repairing Gasholder Tanks," by F. C. Sherman.

"Trouble in Purifying Gas from Sulphurous Coals," by N. W. Gifford.

"Some Experiments on the Rate of Purification," by George F. Goodno.

In addition to the above, several papers are promised, but the subjects have not at the time of writing reached the Secretary.

Persons eligible for membership and wishing to join the Association will please send to the Secretary for blank forms of application.

CHARLES H. NETTLETON, Secretary.

[OFFICIAL NOTICE.]

Annual Meeting of the Southwestern Gas Association.

SOUTHWESTERN GAS ASSOCIATION, DENISON, TEX., Jan. 5, 1891.

We herewith hand you a programme of the next meeting of the Southwestern Gas Association, to be held at San Antonio, Tex., on the 10th and 11th days of next March. The officials of the San Antonio Gas Company have expressed a willingness to provide accommodations for all attendants at our next meeting. You can communicate direct with them. You will please bear in mind the knowledge to be derived from the discussions from the papers to be read at these meetings. We expect a good attendance, and must have you with us. Do not fail to come. Our Question-Box is open for your queries. Information can be had through it that can be received through no other channels. Trusting to be favored with your presence, we are,

Yours fraternally, WM. ENFIELD,
J. R. CULLINANE,
Committee on Programme.

Programme.

Address of President, A. E. Judge, Austin, Tex.

"Advantages of a Gas Engineer Being a Member of a Gas Association," by the President.

"Gas Coals of the Southwest," by Wm. Enfield, Dallas, Tex.

"Condensation and Leakage in the Southwest," by C. P. Russell, Galveston, Tex.

"Regenerative Furnaces in the Southwest," by E. A. West, San Antonio, Tex.

"The Steam Jet Exhauster and Condensation," by J. C. Lord, Fort Worth, Tex.

"Candle Power in Competition with Electric Lighting," by Leonard Gill, Corsicana, Tex.

"Electric Lighting in Connection with Gas Lighting: Comparative Prices and Profits of Each," by J. J. Walsh, Paris, Tex.

"Fuel Gas and Gas for Fuel," by J. R. Cullinane, Denison, Tex.

"Gas Making in the Southwest: Its Advantages and Disadvantages," by Joshua Gill, Houston, Tex.

"Market for Residuals in the Southwest," by J. L. Brockenborough, Waco, Tex.

"The Commercial Possibilities of Gas," by Thos. Miller, Fort Worth, Tex.

"The Gas Man's Easy Chair: Has he One?" by Maj. Davis, Sherman, Tex.

"Mains, Services and Drips," by Elmer Jones, Paris, Tex.

"Gas Stoves and a Special Price for Gas as Fuel," by G. R. Vaughn, Houston, Tex.

"The Alternating Current," by J. H. Maxon, Waco, Tex.

"Carrying Gas into Mexico and to Mexicans," by M. L. Hickey, El Paso, Tex.

AUSTIN GAS LIGHT AND COAL COMPANY, AUSTIN, TEXAS, Jan. 29, 1891.

Queries can be sent to me here, or to Secretary Russell, at Galveston, and we will deposit them in the "Question Box" for consideration at

the next meeting of the Southwestern Gas Association, to be held at San Antonio on the 10th and 11th of March, 1891.

Vice-President West has made arrangements for those who wish to stop at the Menger Hotel, and he writes me that he will see about our getting such accommodations at reasonable rates.

The indications are that we shall have a good attendance and a pleasant and profitable meeting.

In the candid, free and good-natured discussion of our several experiences we will severally and collectively gain much useful knowledge; besides, our meeting in this way will make us better acquainted, will develop our fellow-feeling and sympathy for each other, which will ripen into life long and useful friendships. Fraternally yours,

A. E. JUDGE, Prest., Southwestern Gas Association.

[OFFICIAL NOTICE.]

Ohio Gas Light Association.

OFFICE OF SECRETARY, COLUMBUS, O., Feb. 10, 1891.

To Members of the Ohio Gas Light Association:

Gentlemen—The Seventh Annual Meeting of this Association will be held at Zanesville, O., on March 18 and 19, 1891.

The Clarendon, a first-class hotel, has been selected as the stopping place for our members. Its rate is $3 per day. Those intending to attend the meeting should write well in advance for rooms. *This is important.* In case you should fail to find accommodation at the Clarendon, the Kirk House, famous for its excellent fare, is near at hand.

The sessions of the meeting will be held in a large room, exactly suited to our needs, in an office building at the corner of Sixth and Market streets, on the same lot with the exhibition plant of the Ohio Fuel and Incandescent Lighting Company. It is in a quiet locality, about two blocks from the Clarendon.

The usual exhibit of gas stoves, burners, engines and other appliances and devices of interest to gas men will be held in a large, well lighted room on the ground floor of the Shinnick Building, on Main street, on the direct route between the Clarendon and the convention room. This exhibit promises to constitute a very interesting feature of the meeting.

The following papers have been promised, and probably one or two more will be announced later:

1. "The Proper Handling of Oxide of Iron in Purification," by H. W. Douglas, Ann Arbor, Mich.
2. "The Desirability of a Uniform System of Gas Companies' Accounts," by A. P. Lathrop, Columbus, O.
3. "How Small a Works can Profitably Utilize Its Ammoniacal Liquor?" by George Osius, Detroit, Mich.
4. "The Alleged Popular Prejudice against Gas Companies, and How Best to Eradicate it," by Eugene Printz, Zanesville, O.
5. "A Consideration of the Arguments for and against Water Gas, in 1891," by F. H. Shelton, Phila., Pa.
6. "Does Ohio Want a Gas Commission?" by Irvin Butterworth, Columbus, Ohio.
7. "The Present Outlook for Manufactured Fuel Gas," by George H. Christian, Jr., Norwalk, Ohio.

In addition to the foregoing papers, a "Question Box," which proved such a profitable and interesting feature of our meeting last year, will be had again this year, to which members are requested to contribute queries.

A good meeting is expected, and all members are earnestly urged to be present, prepared to participate in the discussions. Persons eligible for membership, who are not yet members, are cordially invited to attend this meeting and join the Association. Blanks for applying for membership furnished on application. Respectfully,

IRVIN BUTTERWORTH, Secretary.

BRIEFLY TOLD.

THIS WEEK, AT BOSTON.—Our current official notice of the meeting at Boston this week is the last advance announcement of the annual gathering of the New England Association, and it will be seen from a perusal of it that the title of the paper promised by Mr. Allyn, of Cambridge, has been materially changed. Instead of writing on the subject of the renewal of service pipes and street mains, Mr. Allyn will give us his ideas on different methods and devices for accomplishing similar ends. The change in the subject is a radical one, but the author is sure to have something original to say, and it is equally certain that his presentation of the matter will be interesting and graphic. The addition to the list—it came to hand (and appeared in our last issue) at a very late hour one week ago—is a paper by Mr. N. W. Gifford, of New Bedford, on trouble experienced in purifying gas from sulphurous coals, difficulties and vexations in respect to which have been encountered by every gas man, at one or another period in his working. From all that we hear, the convention is to be interesting and profitable. All possible advance arrangements for the convenience and comfort of the members have been made, and a representative attendance is assured. It is perhaps to be regretted that the Thirteenth Convention of the National Electric Light Association is to be in session at Providence, R. I., on the 17th, 18th and 19th, but we are not far wrong in predicting that Boston will have the greater charm for even those gas men who have yielded to the allurements of the dual supply.

THE MEETING OF THE OHIO ASSOCIATION.—Secretary Butterworth's first official reminder that the Ohio Association will meet in Seventh Annual Convention, at Zanesville, on the 18th and 19th of March, also appears in our columns to-day. So far no less than 7 papers have been promised, and if their titles are to be accepted as proof of their worth, the meeting will be well worth attending. The papers are all on live subjects, and we are also more than pleased to note that the gas apparatus exhibition feature is to be repeated. It was a pronounced success last year, hence it is reasonable to infer that the experience there gained will be turned to such good account that the record for '90 will be exceeded by that of '91.

WHAT GOOD MANAGEMENT WILL ACHIEVE.—That good management goes a great way towards making gas works investments profitable is amply shown in the following concise statement, which relates to a gas works operating a combined coal and water plant. The coal gas equipment (benches of 5's) was completed in 1872, and the water gas set is of the Granger type, about 1882. Nothing in the way of plant enlargement has since been undertaken, ordinary repairs of course having been kept up. All materials used and the class of labor as well, are similar to those obtaining in the place 10 years back. Wages have remained unchanged, save a slight increase in yard labor. The Superintendent in charge did not really assume control until July, 1887. Sewerage extensions last year account for the increase in leakage, and the city holds two independent electric light companies, each operating an incandescent service. The name of the Company is witheld for obvious reasons.

Statement of Gas Made and Sold, with Account of Labor for Same. The labor account includes *all* labor for gas in holder (except superintendence), also labor and ordinary repairs around the works, with *labor* of setting benches. All taken from Company's records.

Date.	Gas Made. Cubic Feet.	Sold by Meter. Cubic Feet.	Per Cent. of Loss.	Labor Account at Works.	Increased Amount Gas Sold. Cu. Ft.	Decreased Expense for Labor.
1886...	47,680,700	40,417,000	15.23	$6,984 81	....	.....
1887...	49,996,100	43,658,300	12 06	6,729 52	3,241,300	$255.29
1888...	49,250,900	45,738,500	7.13	5,856 03	2,080,200	873 49
1889...	51,635,800	47,242,600	8.58	5,332 19	1,504,100	523.84
1890...	53,629,600	48,195,400	10.13	4,702 92	952,800	629.27

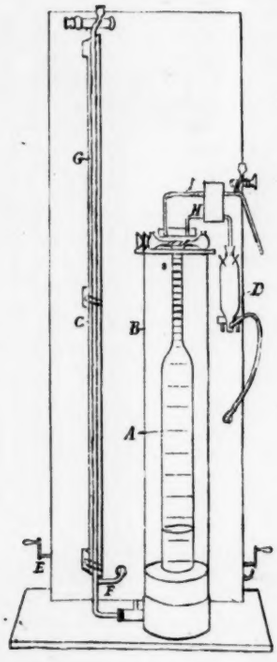
The purification, per bushel of material used, has increased from an average of 2,775 cubic feet, during 1886, to 14,301 cubic feet during 1890. Yield per mouthpiece (when making coal gas) has increased 25 per cent. There has also been a saving of over 6 per cent. in the materials used in the production of gas.

NOTES.—The Milwaukee (Wis.) Council Committee on Judiciary, the members whereof have been considering the propriety of granting a franchise to the projectors of an opposition fuel gas company, have handed in a majority report against the measure. This likely quiets that ghost, for a time at least.——We understand that Mr. Edwin Evans, of Spencer, Mass., has been appointed Superintendent of the Citizens Gas Light Company, of Willimantic, Conn.——The Philadelphia (Natural) Gas Company some time ago instituted the following practice in the collection of its quarterly bills: A statement of the indebtedness is printed on a postal card, with the request that with the remittance the card be returned. The amount is then receipted for on the same card, a 2 cent stamp is affixed and the card is again deposited in the mails. This saves the labor of writing two addresses; also, one cent postage on each bill. The customers, however, object to the procedure, urging that the amounts they owe the Company should not be made public.——Mr. Champlin, of Suffolk, Mass., has introduced an order in the Legislature abolishing the Board of Gas and Electric Light Commissioners, and substituting therefor a Board of Gas and Electric Light Control, to be composed of 1 gas engineer, 1 electric light engineer and 1 lawyer.

Aldeny's Gas Analysis Apparatus.

[Mr. W. E. Aldeny, Curator and Examiner in Chemistry, Royal University, Dublin, contributes the following, respecting apparatus for gas analysis devised by him, to the *Chemical News*:]

The apparatus was originally designed to serve the double purpose of collecting and determining the gases incident to water analysis. In practice, however, it was found applicable, among other things, to gas analysis by absorption and combustion, and to the analysis of carbonates, nitrates, and organic matter by the permanganate method. It consists of a gas burette *A*, enclosed in a glass cylinder *B*, 75 mm. in diameter; a barometer tube *C* (which may also be employed as an open pressure-tube); and a laboratory vessel *D*—the whole being supported on a wooden stand, in the manner shown in the illustration. The supply of mercury to the burette and pressure-tube is regulated by means of a reservoir, which can be raised or lowered by a pulley and small windlass *E* fixed to the back of the stand. The flexible tube from the reservoir passes through a hole in the back of the stand, and is attached to the pressure-tube by means of the small side tube *F*. The height of mer-



cury in the pressure-tube is read off by means of a millimetre scale etched on the unsilvered surface of the narrow slip of looking-glass *G*, which is fixed close to the back of the pressure-tube, and inclined to the vertical plane, as shown in the drawing, so as to reflect the image of the tube from the portion of the glass bearing the scale. The burette and pressure-tube are each provided with a Friedrich's patent glass stopcock, of the pattern shown. Two branch tubes *H I* spring from the stopcock of the burette. The former is a capillary tube, and serves to connect the burette with the laboratory vessel *D* and other purposes; while the latter has a wider bore (2 to 3 mm.), and is intended to connect the vessel containing the substance to be examined with the burette. The two tubes are firmly held against the wooden block shown, which is grooved to receive them, by a brass plate lined with cork and screwed to the block. The contracted portion of the burette immediately below the stopcock is about 225 mm. long, and has a capacity of 15 c.c.; the wider portion is about 410 mm. long, with a capacity of about 250 c.c. Both portions are graduated; the former at intervals of 1 c.c., and the latter at intervals of 25 c.c. The pressure tube is 1,000 mm. long; and as it can be employed both as an open and closed tube, a volume of gas may be measured under a pressure equal to 1,500 mm. of mercury, or, on the other hand, under as low pressure as 1 mm.

The laboratory vessel differs in principle and shape from the one employed in Frankland's or Macleod's apparatus. The lower or cylindrical portion is 25 mm. internal diameter and 55 mm. long, and is furnished with a side tube for connecting the vessel with an independent mercury reservoir. The middle portion is 45 mm. in diameter, and 100 or 190 mm. long, according to the character of the analysis to be made. The upper part, which is of an inverted conical shape, is 55 mm. long; the diameter decreasing from 20 mm. at the mouth to 4 mm. at its narrowest part. Two platinum wires are sealed into the vessel in the positions shown in the drawing. The particular shape given to the upper portion allows the vessel to be easily connected to or disconnected from the tube *H*. When it is desired to disconnect, its lower portion is drawn forward sufficiently to clear the shelf, and is then lowered to detach it from the tube *H*. By reversing these movements, the vessel may be again attached to the apparatus. For some problems in gas analysis the laboratory vessel may be employed in the ordinary way. The lower and open end is immersed in a mercury trough, and may be filled from the trough in the following manner: The stopcock is opened to the tube *I*, and the reservoir raised until the burette is full of mercury; the stopcock is then turned to open to the tube *H*, and consequently to the vessel. The reservoir is now lowered slowly, and as the level of the mercury in the burette sinks, it rises in the vessel. The reservoir is lowered until the vessel is full. The air drawn into the burette during the operation is driven out into the atmosphere by opening the cock to the tube *I*, and again raising the reservoir. When the burette is full of mercury, the glass cylinder filled with water, and the pressure tube in proper order, the apparatus may be used in a similar manner to that of Frankland or Macleod.

Since, however, the apparatus can be employed as an air pump similar in principle to Friedrich's new pump, as well as for measuring and analyzing gases, its applicability to a great variety of purposes becomes possible, if the laboratory vessel is furnished with the means of filling it with mercury, as well as of adjusting the level of mercury in it, independently of the burette. This may easily be effected by closing the lower end of the vessel with an india rubber cork, and connecting it by means of the side tube to an independent adjustable reservoir, which is raised and lowered by means of the pulley and windlass *J*, fixed to the back of the stand, just as in the case of the reservoir furnished for the burette and pressure tube.

To calibrate the burette, it is filled with water in the following way: The burette and glass tube *H* are first filled with mercury by raising the reservoir; a beaker containing water is then held under the open end of *H*, and the reservoir lowered until the burette is filled with water down to the lowest division line. The beaker is now replaced by a small tared flask, and the reservoir slowly raised until the next division on the burette is reached by the mercury; the water displaced being received into the tared flask and weighed. A similar operation is repeated for each division on the scale of the burette. Finally, the capacity of the tube *H* is measured. During the process of calibration, the wide glass cylinder surrounding the burette is filled with water, in order to maintain the water in the burette at a constant and known temperature.

During the analysis of a mixture of gases, all measurements are carried on with the level of the mercury in the burette adjusted to the same division line. The selection of this line will naturally depend on the volume of gas to be analyzed, and the object of the analysis. The process is conducted in the manner now usually followed with this class of apparatus. To absorb the carbon dioxide, a few drops of a strong solution of potash are introduced into the laboratory vessel thus: The stopcock of the burette is closed, the reservoir of the laboratory vessel is fixed above the level of the reagent tube, and a small pipette containing the solution of potash is connected with the india-rubber tube attached to the reagent tube. As the reservoir is above the level of the reagent tube, on unscrewing the Bunsen clamp there will be a tendency for the mercury to flow into the small pipette; and this may be taken advantage of in order to expel the air that collects in the open end of the india-rubber tube to which the pipette is attached. The air having been completely expelled, the reservoir is dropped to a level slightly below that of the reagent tube, and after a few drops of potash solution have been drawn into the laboratory vessel, the Bunsen clamp is screwed up again. The stopcock may now be opened, and the gas passed from the burette into the vessel. After about 10 minutes, the carbon dioxide may be considered to have been completely absorbed, and the remaining gases may be transferred to the burette and again measured, after the mercury has been once more adjusted to the levels as before. The remainder of the analysis does not need any further detailed description.

When commencing to experiment with the apparatus, it was anticipated that a correction for the error introduced by the bubble of gas being retained in the laboratory vessel, as above described, would be necessary when calculating the volume of the gas. In order to determine the amount of this error, Mr. J. Carson (a friend and former pupil of the author) made a number of experiments with the apparatus. About 175 c.c. of air were drawn into the burette through the tube *I*, the stopcock was closed, and the air was compressed until the level of the mer-

cury in the burette reached the 100 c.c. division. The pressure exerted by the air was then found to be equal to 410 mm. of mercury *plus* that of the atmosphere—viz., 759.51—that is, a total pressure of 1,169.51 mm. of mercury. The air was then passed into the vessel and back again ; the mercury being returned to the same level in the burette. The pressure was read, and found to be exactly the same as before—viz., 1,169.51 mm.

The experiment was repeated, and a like result obtained. It was then decided to try a similar experiment with a small volume of air under reduced pressure ; when the difference indicated was found to be less than 0.1 mm. It is therefore evident that the bubble of gas retained in the laboratory vessel is too small to introduce any appreciable error when the adjustments of the levels of the mercury in the burette and vessel are made, before carrying out measurements, in the manner above described.

The author gave some results, taken at random, of analyses of sewage and of air, to show the degree of accuracy ordinarily attainable with the apparatus. With reference to the possibility of maintaining it in good working order, he said he had employed it for a large number of experiments of various kinds, and had not found any difficulty in keeping the stopcocks in such good order that a vacuum could be maintained unimpaired in the burette and pressure tube for several days. He added that other advantages of the apparatus, besides simplicity and wide range of applicability, were its comparative freedom from the risk of breakage, and its cheapness ; the whole cost not exceeding $25.

The Pitot Tube Gauge for Measuring Natural Gas.

Prof. S. W. Robinson, M. E., of the Ohio State University, was delegated to compile and prepare Chapter VII. of the last report of the State Geological Survey, and the Professor confined himself mainly to a report on the determination of the quantities of natural gas used in various industries to effect certain results—such for instance, as the quantity of gaseous fuel required to burn a certain number of brick, and so on. In the pressure and flow determinations a modified form of the Pitot tube gauge was employed, and the portion of chapter VII. devoted to a description of the modified form of Pitot's apparatus used is here reproduced :

This is a perfect instrument, if we may call one perfect when its practical results agree with the theoretical ones, while at the same time the instrument itself may be either fine or rude in its construction.

Figs. 1 and 2 illustrate the simplest forms of the instrument as used at the gas well mouth or at the exit mouth of a pipe, or in fact any discharge orifice such as openings in the side of a tank from which the flow is free into air.

In Fig. 1, *B* is a tube which for convenience is bent to an angle so that its mouth end can readily be placed as required, square in the stream of gas flowing from *A*. A piece of rubber tubing *C* connects *B* with a glass tube *D*. The opposite end of *D* is connected with rubber tubing *E* to a second glass tube *F*. All this tubing is open free throughout.

In using this instrument it is charged with water or mercury and held as shown, so that the difference of level ($D\ F=h$) can be read off. Elaborate tables have been prepared from which the value of h in inches can be at once determined.

Fig. 2 is intended for the case where the pressure produced by the impact of the stream against the open end *B* is too great to be conveniently measured by water or mercury, the pressure here being measured by a pressure gauge. The size of the mouth *B* is immaterial. In some cases the pressure in Fig 2 has been observed as high as 50 pounds per square inch.

In Fig. 3 is given the form of tip and of instrument to be used in such cases as measuring the velocity of flow at any point in a pipe line where the pressure of the flowing gas is above or even below that of the air. This instrument has been used in pipes where the pressure was above 100 pounds per square inch without inconvenience, or detraction from accuracy of results.

In this form, Fig. 3, the tip *AB* is seen to have two openings, the Pitot tube mouth proper, *A*, the same as Figs. 1 or 2, and besides this, the lateral opening at *B* in the smooth uniform side of the tip. In ordinary cases of pipe lines, *B* may be at some distance from *A*, even in a separate piece of tube. But for convenience of application to the pipe lines the double tip is made so that it may be screwed air tight into a single ¾-inch pipe size hole. The end *AB* is then bent into an L of 90°, so that *A* may be made to face up stream to catch the current, while for *B* the gas moves past without increasing or diminishing the pressure in *B* as due to motion of gas, while yet the standing or static pressure is transmitted into *B*. Thus the pressure exerted at *A* when the instrument is in use on a pipe line, is equal to the static pressure in the pipe *plus* the pressure due to impact, or to velocity of current, while at *B* the static pressure only is exerted. The static pressure is that which we measure by a pressure gauge placed on the pipe line.

It is apparent from Fig. 3 that the pressure at *A* is transmitted to *C*, and that at *B* to *D*.

To complete the instrument, a gauge in the form of a U-tube of glass containing water or mercury is placed at *C D*. Then the *C* side of the water or mercury in the U will stand lowest, and the difference of level will be the head due to velocity. This head for inches of mercury or of water will be found in the tables above alluded to. It will be rare that ever a higher pressure than 10 inches of mercury will be observed on any pipe or service pipe, so that it is not necessary to provide high pressure gauges for *C* and *D*.

The pressure observed in Figs. 1 and 2, or that at *C*, Fig. 3, in excess of that at *D*, is produced by the swift moving gas driving against the mouth *B* and being brought there to a stop. By the theory of the instrument the gas compressed into the tube at *B* would, by being permitted to flow out again against the same surrounding pressure, attain

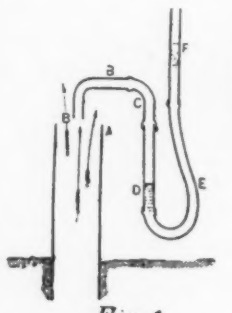


Fig. 1

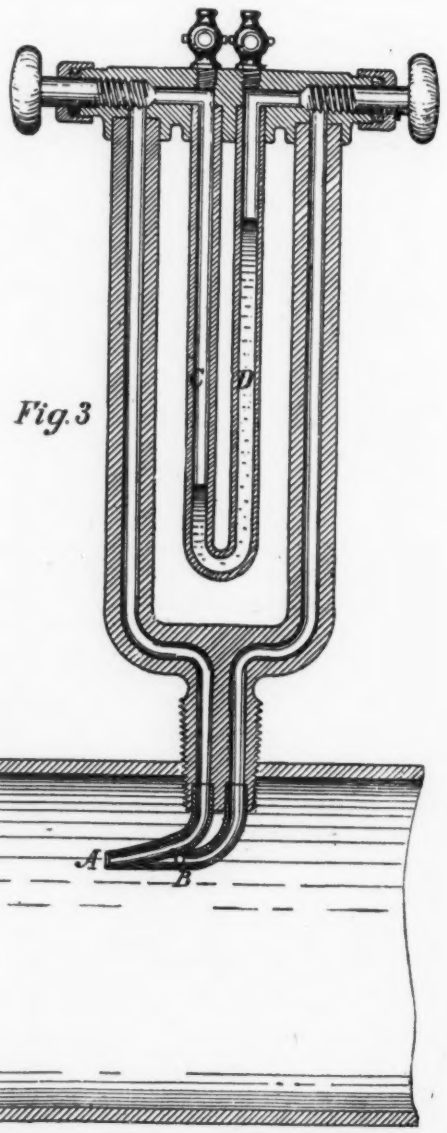


Fig. 3

Fig. 2

the same velocity as that in the stream from which it was brought to rest. Not only is this realized perfectly by experiment for the pressures, but the like holds good relative to temperatures.

In the application of the instrument to gas wells, which is a case where the static pressure is that of the atmosphere at the point of observation, the mouth *B* of the tube being placed at the plane of the orifice *A*, at which point the internal pressure of the inflowing gas will be that of the air into which the gas flows. The simple form of the apparatus shown in Figs. 1 and 2 will be all that is required. The size of the openings *A* and *B* is immaterial, so long as they are not so large as to obstruct the flow of the current, or so small as to become clogged by particles of foreign matter floating in the current.

The volume in cubic feet of gas per day of 24 hours of uniform flow may be calculated from the formula

$$V = 1{,}462{,}250d^2\left[\left(\frac{P + 14.6}{14.6}\right)^{0.29} - 1\right]$$

where d = diameter of well mouth or of orifice in inches, and p = the gauge pressure in pounds per square inch. In using this formula temperature and density corrections should be taken into account.

In applying the instrument care should be taken to so place it that it will receive the normal flow of gas, and its readings be not rendered nugatory by eddyings in the current caused by adjacent pipe connections, tees, etc. With normal flow the tip should be held at one-fourth of the diameter, and if at the center, the apparent volume should be multiplied by .97 to correct the so-called velocity curve.

Regarding the flow of gas in long pipe lines, it has been stated that the quantities transferred considerably exceed the amounts determined by the ordinary formulas for calculating gas flow in pipes. This is probably owing to the fact recently determined by trial that the co efficient of the gas under the condition of flow of high pressure and comparatively low velocities, is much lower than usually allowed, indeed for some observed values, less than one-half that value. This fact makes it desirable that some reliable and convenient method of measurement be used in which the element of friction be elminated. A meter of sufficient capacity to do this work would be very expensive besides very troublesome to apply.

By the use of the form of gauge shown in Fig. 3 the above mentioned qualities of small cost, ease of application, and accuracy of results, are attained in the highest degree. In the figure referred to the gauge is shown as applied to a pipe line, $A\ B$ being the double mouth tip, and $C\ D$ being the 10-inch U-tube gauge for water, alcohol or mercury.

The volume in cubic feet of gas per hour flowing through the pipe may be calculated from the following formula :

$$V \text{ per hour} = 1{,}690\, d^2\sqrt{h\left(1 + \frac{p}{15}\right)}$$

where p is the gauge pressure in pounds per square inch of the gas flowing in the pipe, d the inside diameter of the pipe in inches, and h inches of water, the temperature of the flowing gas being taken at 40° F., and that of storage at 50°.

In the placing of the instrument on pipe lines care should of course be taken to remove it from the effects of eddies or abnormal currents produced by pipe fittings of any sort. If it becomes necessary to locate the instrument in a short portion of pipe, say of 15 diameters in length, it should be placed much nearer the down stream end to secure the conditions above named.

To strengthen and confirm confidence in the Pitot tube gauge for accuracy as applied to gas measurements further than that already done by citing its accuracy in streams of water and its agreement with theory in development of pressure due to impact against its tip mouth, some absolute quantitative experiments have recently been made in connection with with a *gas meter prover*, where a known quantity of air was forced through a pipe in a measured interval of time, the same being carefully measured with the Pitot tube gauge, the results of which are given in the following :

Test of Comparative Volumes of Air Simultaneously Measured by the Gas Meter Prover and the Pitot Tube Gauge.

	Diameter of Pipe. Inches.	Volume by Gauge.	Volume by Prover.
12 experiments, October 4, 1890	1.25	173	161
	.865	188	150
	.865	182	185
	1.73	263	240
9 experiments, October 11, 1890	1.23	201	200
	.86	190	188
Means.....	.....	192.8	187.3

Difference less than 3 per cent.

The tube mouth was here placed in the center of the pipe, where the current is most rapid, but the figures were corrected for this, as well as temperature of air and all known causes of error. The final difference of 3 per cent. is believed to be within the errors of observation and might be plus or minus, as indeed the individual comparisons are, indicating that the instrument is practically exact for measurements of gases as well as liquids.

In the course of practical field work with the Pitot tube gauge, it has been applied to pipes which at the same time were conducting gas as measured with the Westinghouse natural gas meter, the latter being read and noted each time. Comparative results thus obtained are given in the following :

Table of Simultaneous Measurements by the Westinghouse Natural Gas Meter and by the Pitot Tube Gauge.

Diameter of Pipe Line.	Gauge Pressure in Pipe.	Cubic Feet per Hour by Meter.	Cubic Feet per Hour by Gauge.
6 inches.	13.6 ounces.	11,970	12,005
3 "	10.4 "	4,430	4,025
6 "	9.2 "	14,933	15,843
6 "	9.2 "	14,933	15,336
6 "	7 pounds.	28,900	29,702
6 "	7 "	32,032	29,460
6 "	7 "	33,050	34,590
6 "	19.2 ounces.	20,930	20,611
6 "	19.2 "	19,063	19,175
6 "	19.2 "	17,990	17,733
3 "	8.8 "	4,307	3,924
6 "	7.0 "	12,720	13,325
6 "	13.8 "	12,310	12,797
Means.....		17,510	17,578

It was not always practicable to make the readings absolutely simultaneous, though they were usually separated by less than 1 minute. In this way the difference between gauge and meter might fluctuate somewhat, as indeed they do. The meter results were fully corrected for pressure and for all other known sources of error, as were likewise the readings of the Pitot tube gauge. The density of the natural gas where the above figures were obtained was 0.66.

With the facts above set forth in view, the above results are in essential agreement, either instrument proving the other satisfactory for accuracy.

Underground Electrical Work.

Mr. David Brooks, writing to the *Western Electrician* on this subject, says :

While looking over the proceedings of the Chicago Electric Club, as printed in your paper, I was preparing myself to walk into that concern and make a disturbance, when I found Herbert Laws Webb had forestalled me, and taken a portion of the wind out of my sails. Still there is a good deal that is left undone. Mr. Degenhardt states : "The insulation resistance should not be less than 500 megohms per mile, and the insulation should not materially deteriorate for the space of two years after being in service on an electric light circuit, having a voltage of from 2,500 to 3,000 volts, and a current of from 9 to 12 amperes, or a voltage of from 900 to 1,200 volts, and a current of from 18 to 20 amperes." A galvanometrical test of this nature for an electric light conductor I consider of no earthly use, but agree with Wm. Maver, Jr., in an article published in the *Western Electrician*, of March 1st, 8th and 15th, of the past year, that a cable measuring 20,000 megohms per mile for insulation in the factory, was broken down by a dynamo current of 600 volts after being drawn into a conduit. In speaking of all these tests Mr. Degenhardt makes no reference to temperature, although in a Chicago atmosphere the insulation resistance is certainly ten times as high at the temperature of freezing as at the temperature of 80.

As Mr. Webb states, the cable should be immersed in water, but even that is not satisfactory if the cables are to be used for electric lighting purposes. The method employed by Johnson & Phillips, of London, is spoken of as follows, in a letter under date of November 4, last, referring to a line laid at Charlton : "We have at last had Ferranti, Dr. Fleming, Gordon and others down to see it. Yesterday we had a current of about 14,000 volts on this line for about 5 hours, and it stood it perfectly ; we took the current from a 2,000 volt Kapp alternator and transformed up to 14,000 volts to the line. At the distant end we had another transformer and converted it to 2,000 volts again, and lighted 20 100-volt 16-candle power lamps in series, and I am writing to Ferranti and others to come and see the test repeated."

Cables that may test enormously high with a galvanometer often break down and disrupt with currents of high voltage, and especially is this the case with lead encased cables : the coiling and uncoiling of this class opens spaces in the insulation which are nothing more than vacuum tubes or Geisler tubes. Varley made use of these years ago to protect ocean cables from atmospheric electricity. Last winter I laid an electric light cable in Gloucester, a No. 0 conductor ; the insulation resistance at that cable at 32° Fahr. is 1,000 megohms per mile ; but in August last when the temperature of water from the hydrant was at 81 the insulation dropped to 3 megohms per mile. This cable stood the current of a 2,000 volt alternating current, but as an experiment we heated a portion of the cable up to 150° Fahr., and brought the insulation up to 5,000 megohms per mile, and tried to break or disrupt the in-

sulation without any effect whatever. It was then tested with a Holtz machine, which produced a spark 6 inches in length to ascertain whether the insulation could be punctured, but without effect. Five thousand megohms per mile does not sound very high, but if the conductor was a No. 3 instead of a No. 0, only one part of the current would go to the earth, while 5,000 parts would keep to the wire.

Currents of great intensity center upon weak spots and develop them into perfect grounds. Culley speaks of this fact and it is for that reason chiefly that the Atlantic cables are worked with only two cells and nothing can be more absurd than the statement, "Electrical currents of infinitesimal potential are no more easily conducted than are those electrical giants of four or five thousand volts." It has especial bearing upon lead covered cables with inside textile covering; coiling and uncoiling is liable to open pores admitting moisture, especially so, when laid under water.

Mr. Sunny says: "In arc light service if we get one megohm to the mile we are perfectly contented." Mr. Sunny, speaking of telephone cables, says: "The company also put down what was known as the Brooks cable, in a 3-inch iron pipe filled with resinous oil. It extended from the business part of the city to Twenty-second street, and never gave satisfaction from the outset. I believe it is still working in some sections, but not in a satisfactory manner." In this connection I quote from Prof. Barrett: "Now then, the question of insulation is another thing, you can get all the insulation you want and a good deal more. I recollect a short time ago that a cable was abandoned here because the insulation was so high that they could not use it. Gentlemen in the room know that to be a fact. They had to reduce the insulation so that the cable would work." A few days ago I was in Chicago and Prof. Barrett said the words just quoted had reference to the Brooks' cable in that city laid four years since. When the cable was first laid, Mr. Sunny wrote that it was a perfect success; in the next letter he stated that there was a great deal of retardation on the Brooks cable. When an overhead cable was connected into it at Twenty second street, and when it was still lengthened by connecting in another cable at LaSalle street, the Brooks cable as a trunk line was nearly worthless; but taking the poorest insulated wire, they could use it fairly well.

I got Geo. H. Bliss to try the cable himself, and he wrote as follows: "Scarcely any cross-talk or induction sounds could be heard by me on the Brooks cable wires in any of these tests. Pronunciation of difficult names was tried on all the Brooks wires with success, except in those cases especially difficult for telephone transmission. This afternoon I went, at Mr. Brooks' request, to the Chicago avenue exchange, where conversation was carried on through a wire in a Patterson cable to the LaSalle street exchange, about one mile distant. The cross-talk and induction were much more pronounced than on the Brooks cable wires used in the morning, although the distance was only one-third as great."

History has record of the better working of ocean cables by putting in leaks. Culley speaks of it in the cables that are laid from island to island in the Mediterranean. Sabins in his work published in 1867, states that Kramer improved the insulation of the underground wires in Germany by reducing the insulation, so there is nothing wonderful in the statement of Mr. Sunny that the poorest insulated worked the best. The great fault with the cable is that the conductors were too large. No. 16; if they had been No. 22 the inductive disturbance would not have been more than half as great. I protested against the use of such heavy conductors, there being 510 in a 3-inch pipe. What is needed in telephone service is not so much volume as distinctness of articulation. Since then I laid a cable of 53 conductors for the Pennsylvania Railroad Company of Philadelphia, and one of them was a very small wire, No. 22, laid for the purpose of a test wire; this cable is used for both telephonic and telegraphic purposes, and it has been found that the small wire serves much better than any of the others for telephone uses, for the reason that it occupies no more than half the space in the inductive field. Using the No. 16 wire you do not reduce the resistance of the circuit, which includes telephones and transmitters, 1 per cent., but you increase the inductive disturbance 50 per cent.

As an experiment we connected in as many as 10 of the No. 16 wires, using them in parallel, and thereby reducing the resistance to merely nothing, or next to nothing, and then listened to the noise. We were enabled to hear the hum of the electric light dynamos. The amount of this is to show that there has been a great deal of copper wasted in telephone cables of short length, but in long distance telephoning, where the circuit is double in length, to make it metallic, then conductivity becomes essential.

Mr. Sunny, referring to electric light cables, makes the following statement: "In the electric lighting business I claim that the underground work is not a complete success for the reason that the lights are apt to go out once a week from some underground defect. The insulation is liable to run down so low on short notice as to require the shutting down of the circuit for repairs." Now, with the Brooks' system, patented in 1887, an entirely different state of affairs exists. With nine installations working, most of them upward of a year, not a single interruption has occurred. Prof. Barrett states: "It is a fact, with the underground system of Chicago to-day, that you deliver more of your product at the lamp than you did with the overhead system." At Gloucester we used Johnson & Phillips' method of insulating the lamps, and with 22 terminals exposed to the rain, we got a much higher insulation than on a clear day at the same temperature, because some of the pipes and lamp posts are exposed to the rays of the sun. An ordinary glass insulator exposed to the smoke and soot, will not show in Chicago in the rain an insulation of over a megohm, and there is a great deal in this particular point of carrying the full current to the lamps as pointed out by Prof. Barrett. There is much said about subways, and conduits. I consider the best of them an unmitigated nuisance, and of no earthly use. Nineteen No. 4 electric light conductors can be drawn into a 5-inch diameter pipe, the conductors not costing over 5 cents a foot. Think of what Mr. Laws says, a good electric light conductor can be had for $1,250 per mile, and that Mr. Degenhardt says the rental of a duct is $1,000 a mile per annum. If electric light companies must pay these figures they should never be obliged to go underground. Mr. Kempt says: "I think in this discussion a comparison of the cost ought to be mentioned for good reasons. So if any gentleman is prepared to give us some figures, showing the difference in cost between aerial and underground construction, I should like to hear them." I would very much like to go into figures, but it is impossible to do so, unless one knows what is wanted; if a person should ask me how much it costs to build houses, I should state it depends very much on the kind of a house you want, and if anyone will specify what is required, I will at once estimate for the work and promise that it doesn't cost one-sixth of any other underground system, and but little or if any more than an overhead system.

Two years since a wood conduit was laid on Chestnut street, Philadelphia, and the street being narrow, the traffic was incommoded by immense heaps of earth that were thrown out. Some electric light wires have been drawn into them, and the conduit has taken fire twice between Seventh and Eighth streets, destroying all the conductors and a portion of the conduit had to be rebuilt. There have been several other fires that have come under my notice, one at Fourth and Chestnut and another at Eleventh and Chestnut; there the conduit had to be rebuilt for half a square. Not more than a couple of months since an explosion occurred at Ninth and Chestnut streets, breaking every window upon one side of a street car.

There are four conduits in Chestnut street. In this same locality, but on the south side of the street, a manhole blew up, and sent up the cover through the window, which consisted of a large French plate glass into the store of Porter & Coates. Between pumping water out and fanning fresh air into these conduits, there is quite a new industry established.

The idea that you can pull in and pull out in making repairs is popular, and that you have spare ducts to put in more conductor when needed, is also popular; but in practice here the first thing necessary after you pull in a cable, is to pull it out again and repair damages. Rubber and gutta percha are soon destroyed when exposed to the atmosphere of a wood conduit. Lead is turned into white lead. Prof. Marks calls wood conduits white lead factories. To preserve the white lead they cover it with a braid saturated with black paint. When drawn into the conduit the paint is as dry as any other paint after it is exposed to the air, and does not adhere to the hand, but after it has been in the conduit a week, this paint becomes liquid, thinned, and leaves a black mark on your hand if you touch it. Illuminating gas is only another form of hydrocarbon or fatty matter, and acts as a solvent, like benzine upon grease spots. The paint and braid preserve the lead for awhile, but are not lasting. About a month since they undertook to draw in some electric light conductors in this wood conduit at Broad and Chestnut streets, and after punching with their iron rods to get a passage for pulling in rope, they found the conduit was rotten, and the whole thing for 60 feet or more across Broad street, the widest street in Philadelphia, had to be dug up, and a new conduit laid. Broad street at this place is paved with asphalt, and the gang of men were making repairs there for about 10 days. Broad street is Fourteenth street if numbered. When they got as far as Fifteenth street they had another circus of the same nature and had to put in a new duct. It seems to me that anybody who would spend money for a conduit at this time must be demented, yet another company is now laying in this same Broad street a wood con-

duit. I consider this a case of aggravated dementation: "If the blind lead the blind, both fall into the ditch," which is the scripture name for conduit. I must quote a scrap from an author of the twelfth century, Mr. Dante: "These may be called flocks of sheep and not men; for if one sheep should throw himself down a precipice of a thousand feet, all the rest would follow; and if one for any cause in passing a road should leap, all the rest would do the same, though they saw nothing to leap over."

The Chicago International Exhibition of 1893.

[A paper read by Mr. James Dredge, of *Engineering*, before the British Society of Arts.]

The suggestion that a great International Exhibition should be held in the United States two years hence appears to date from the summer of 1889, when the rumor spread that Americans, incited by the brilliant results achieved in Paris, determined that a similar celebration, but one that should surpass in extent and grandeur the Centennial Exhibition of the French Republic, should be held on the other side of the Atlantic. The year 1892 was selected because it will be the four hundredth anniversary of the modern discovery of the New World, or rather of some of its detached outposts lying to the southeast of Florida. It was on the 3d of August, 1492, that Christopher Columbus sailed from Andalusia; on October 12th following he took possession, in the name of Spain, of the Bahama Isles, and two weeks later of Cuba. It was not, however, until six years later, and in the course of his third voyage, that he discovered the American Continent; and in this discovery he had been anticipated by Sebastian Cabot, who had been sent out on an exploring expedition by Henry VII. of England, and who was the first to set foot on the American main land; this was on June 24, 1497. The choice of dates was therefore at the option of the organizers of the new scheme, and probably for some reasons it would have been preferable to have delayed the celebration until 1897 or 1898; that, however, would have been to dismiss the undertaking to a rather remote and uncertain future, and it was decided, therefore, that it was the first discovery of Columbus which must be celebrated, and that 1892 should be the year during which the commemoration should be held.

What was only a vague rumor floating over the Champs de Mars last year speedily took serious shape, and it became evident that, on or about the date first spoken of, an International Exhibition would be held in America. There can be no doubt that such a scheme is an eminently practical and useful one. Sixteen or seventeen years will have passed since the great Centennial Exhibition had been held in America; and this long period has been marked by a development of resources, a growth of population, an increase in industry and riches to which history can offer no parallel. In the United States, the Philadelphia Exhibition of 1876 already belongs to ancient history; but it is regarded as an epoch from which is dated the commencement of much that was new and good in American taste and culture, notably as regards house architecture and art publications. The great flood of annual travel from America to Europe had not then set in, and to most of the visitors to Fairmount Park, where the Exhibition was held, the contributions from foreign nations were a revelation. Since that time, of course, increased wealth and facilities for travelling have brought an ever growing crowd of visitors to Europe; and the lessons first taught at Philadelphia have been extended year by year, until the adaptive character of the American has assimilated, more and more, European habits and refinements, and the gulf that separated our manners and customs from theirs is growing narrower day by day.

In the United States, decisive action usually follows with great promptness ideas which are favorably received; in October of last year it was determined definitely, and almost unanimously, that the Columbian Exhibition should be held, and with this determination came the burning question: To what city should be awarded the honor and the responsibility? The claims of New York, of course, stood paramount, partly because to New York was due the credit of the original proposition, but chiefly for the reason that New York is the metropolis of the United States, the most cosmopolitan city in the world, and the one best known to Englishmen. Situated on the sea, with a harbor that allows the largest ships to moor alongside her wharves, the facility her position offers to visitors, as well as to the goods sent by exhibitors, are unquestionably very great. To the city of New York, indeed, it seemed as though no other town could successfully contest her fitness or her right to the Exhibition of 1892; but American rival cities are enterprising and presumptuous, and several others advanced claims more or less reasonably and stoutly maintained. Washington and Philadelphia, St. Louis, Cincinnati and Chicago, all entered the lists. Only one serious opponent remained, however, to New York after the first encounter; Philadelphia, who had snatched the honors of the Centennial Exhibition of 1876, could not expect a repetition of the same good fortune, which would have stamped her as the exhibition city of the United States; Washington, beautiful and attractive as she is, is wholly given up to political instead of commercial enterprise, and made no serious effort to gain a privilege that was thrust upon her rather than sought; St. Louis was too remote, and Cincinnati not large enough for such a responsibility, so in a very short time it became evident that the selection lay between Chicago, a thousand miles inland, and New York. Before matters had been settled thus far, the approval of the Senate and the President had constituted the Columbian Exhibition as an enterprise indorsed and assisted by the Government, so that from the beginning its official character was clearly defined. As much to the surprise as to the indignation of New York, the city of Chicago maintained its claim.

With characteristic enterprise, its citizens had, before the fray commenced, organized a corporation with a large capital. Not that it was intended to degrade the scheme by making it a commercial speculation, but because it was recognized from the commencement that the greater part of the capital necessary for carrying out this enterprise successfully must be raised in the city. Immediately after this had been done, delegates were sent to Paris to confer with M. Berger and other directors of the French Exhibition just closed, to obtain all such information as would be useful in carrying on the conflict about to commence, and to organize the Exhibition afterwards.

One of the delegates was Mr. E. T. Jeffrey, and the other Mr. O. Chanute, a well known American engineer. The report prepared by these gentlemen, during their visit to Europe, was very long and exhaustive, and it proved of considerable service in the struggle that afterwards took place at Washington. Of this struggle it need only be said that it was protracted and severe; New York and Chicago were practically the only claimants in the field, and much oratory and cunning argument were put forth on both sides. Probably New York committed the dangerous error of underrating its opponent; and certainly it had the fatal misfortune of suffering from political internal fueds which of itself was sufficient reason for its losing the contest. In the end, Chicago came out signally victorious; and, on April 25th of the present year, an Act of Congress was approved, providing for the celebration of the "Four Hundredth Anniversary of the Discovery of America by Christopher Columbus, by holding an International Exhibition of Arts, Industries, Manufactures, and the products of the soil, mine and sea, in the city of Chicago." This legislation, while it constituted the Columbian Exhibition a Government undertaking, pledged the United States Treasury to but little expenditure, although there is but slight reason to doubt that, should the necessity arise, patriotic feeling at Washington, combined with the senatorial pressure from the Western States, would assure a liberal amount of Government aid.

To such an extent is the Exhibition regarded as a Government undertaking, that the Act of Congress above referred to provides that the general control shall be vested in a United States Commission, composed of 2 Commissioners from each State and Territory, and of 8 special members: this body is recognized as the Columbian World's Fair Commission. As a matter of fact, this Commission was appointed in duplicate, so that a reserve force should always be on hand to fill up vacancies. The chief functions of this Commission were to decide upon the site available for the Exhibition; to approve of the buildings and general arrangements; to make allotments of space, to classify exhibits; to determine the plan and scope of the undertaking; to appoint the juries and confirm awards; and to make all arrangements with foreign exhibitors. The actual carrying out of details, and, in fact, the responsibility of the undertaking falls, however, upon the Executive Committee, which has been formed from the original organization of Chicago citizens, the Washington Commission being instructed to withhold their assent to any actual steps being taken until the corporation could show that it possessed a *bona fide* subsciption of at least $5,000,000, of which 10 per cent. was paid up, and a further guarantee of $5,000,000, making in all $10,000,000, to provide for the expenses of construction and management. So soon as formal notification to this effect has been given by the Commission to the President of the United States, he will make proclamation of the fact, and will communicate with the diplomatic representatives of foreign nations, and through them invite their respective Governments to take part officially in the Exhibition. As regards the active participation of the Government as an exhibitor, it is provided that a sum of $500,000 should be devoted to the erection of a Government building, to be filled with Government exhibits, which would be collectively contributed from various executive departments, such as the Smithsonian Institution, the United States Fish Commission, and the Na-

tional Museum; the control of this collection being vested in a special committee. Another Government exhibit will be the complete reproduction of a first-class life-saving station, of which there are many on the American coast. The President is also empowered under the Act to hold a grand naval review in New York Harbor in April, 1893, and in which the navies of foreign nations will be invited to participate. Besides the foregoing, the American Government makes itself responsible for various other sums, the total authorized outlay being $1,500,000.

The corporation, acting under the general control of the United States Commission, consists of a board of 45 directors, all of them carefully selected with reference to their influence and standing; of these the President is Mr. Lyman J. Gage, one of the leading bankers in Chicago, and the Secretary is Mr. Benjamin Butterworth, who is well and favorably known in political circles at Washington. The Director General, elected only a few weeks since, is Mr. George R. Davis. Out of the body of Directors a number of committees were formed; the Executive Committee with 13 members, and others dealing with finance, grounds and buildings, legislation, national and State exhibits, foreign exhibits, catalogues and printing, transportation, fine arts, mechanical and electrical appliances, and ways and means.

The President of the United States has not yet issued the invitations of participation to foreign countries, because the financial conditions prescribed by the Act of Congress have only been very recently complied with, but it is expected that they will be delivered within a few weeks. It is very confidently asserted that as regards money, the prospects of the Exhibition are absolutely sound. About $6,500,000 have been subscribed by the citizens of Chicago and the various railway companies interested in the undertaking; of this amount $1,000,000 has been actually paid, and the balance is available on call as the necessity arises. It is anticipated that further subscriptions of $1,500,000 under this head will be received. In addition to the foregoing, the city of Chicago is about to issue bonds to a further extent of $5,000,000. This issue was decided on at a special session of the State Legislature in July last. According to the law in the State of Illinois, it is illegal for any city or township to issue bonds for a larger amount than 5 per cent. of the assessed real estate valuation of the city. Now the actual debt of Chicago, though only $12,000,000 (about $10 per inhabitant), made it impossible for the municipal authorities to have raised any such sum as they required under the existing law. The vote of the electors, recorded on November 4th last, showed a unanimous approval of the action of the Legislature in passing a special measure. The people of Chicago alone have thus subscribed $11,500,000; it is proposed hereafter to issue further bonds to the extent of $5,000,000, secured by the receipts from visitors. This measure has doubtless been suggested by the highly successful policy at the Paris Exhibiton, which secured, in 24 hours, no less than 30,000,000 francs to the Exhibition treasury; what constituted the great charm of this operation to the public was the fact that a lottery was attached to it: but this feature will be absent from the Chicago Exhibiton bonds, since lotteries of all kinds are regarded with disfavor in the United States. So far as the first item of capital is concerned—the $6,500,000 subscribed—it is recognised that the amount, if the undertaking turn out to be a financial failure, will be lost, while the $500,000 of city bonds will be added to the municipal debt, and gradually extinguished during a term of years. It is too much to expect that the Exhibition will turn out to be so remarkable a success as to repay all the money thus advanced; still, it is hoped, and with reason, that, after the entry bondholders have been paid—with a fair amount of interest yet to be decided on—that a balance will be left in the Treasury. In such an event, the amount will be divided *pro rata* between the city and the various bondholders. The people of Chicago maintain that they are quite prepared to accept the loss of the whole sum, if needs be, being convinced that the glory which will be reflected on their city, and the indirect profits which the Exhibiton will bring, will in the end, far more than repay them for the money lost. But the figures I have just mentioned do not by any means represent the whole of the resources which will be available for Exhibition purposes. In the first place, the United States Government stands committed for an expenditure of $1,500,000; and, as has been hinted above, the persuasions of Western senators may, in case of necessity, charm far larger figures from the Treasury. There is no doubt that all, or nearly all, of the various States will appropriate large sums for their own exhibits, and, while these will not swell the capital of the Chicago Corporation, they will contribute, in a very large degree, to the completeness of the Exhibition and the beauty and variety of its buildings. The Legislature of the State of California has taken the lead in the matter, by appropriating $1,000,000 for its Exhibition expenses; and in other States the sums to be contributed for the same purpose are now being discussed. The total expenses of the Paris Exhibition last year amounted in round figures to £3,000,000. As the Chicago Corporation has already in sight a sum of nearly £3,500,000 sterling, it will be seen that, making full allowance for the greater cost of everything in the United States, the financial part of the undertaking is fairly provided for.

One cannot help wondering why a claim was not put forward—when the battle of the sites was being fought—for the village of Niagara; it is difficult to conceive a location possessing more natural advantages than the area around the great Falls. It would have been neutral ground, over which no jealous rivalry would have been wasted, such as that which was so active between the large contending cities; the hearty cooperation of Canada would have been secured; the waterfalls and the rapids above and below would have proved an irresistible attraction to the whole world, compared to which the interest felt in the Eiffel Tower would have been as nothing; the Cataract Company for utilizing the water power could have been in operation in 1893, and could have furnished all the power required for driving the machinery in motion and for other purposes. Niagara is not remote from New York, and at the same time it lies at the door of Canada; it is on the direct route to the great West, and has abundant communication in all directions by rail, lake, and canal. The fact that the place itself is but a village, and that the adjacent city of Buffalo possesses only a limited accommodation for visitors, would have been difficulties easily overcome by the enterprising American speculator and hotel keeper. It is true that the powerful local interests which will give the Chicago Exhibition extraordinary scope and vitality would have been wanting; but, on the other hand, it is reasonable to suppose that such a scheme would have been supported by a unanimous national enthusiasm, and with the Falls of Niagara as a leading attraction, would have commanded a universal interest abroad.

It being, however, definitely decided that the Columbian Exhibition of America is to be held in Chicago, it will be both interesting and useful to form some opinion as to the actual advantages of the site, both from a national and international point of view. This question having been settled, it is quite unnecessary to consider whether New York, Washington, or any other city would have been preferable. So far as foreign exhibitors are concerned, it would appear at first sight as though the commercial metropolis of the United States, situated as it is on the Atlantic seaboard, would have offered far greater advantages than those possessed by a city a thousand miles inland; it must be remembered, however, that facilities for transport are not the only questions which arise in connection with advantages to be derived from taking part in a great exhibition. The main object of an exhibitor is to bring his exhibis under the notice of the greatest number of probable purchasers, and the people of Chicago claim that their city possesses this advantage in a higher degree than any other town in the United States. Whether this be true or not, it is beyond dispute that Chicago is the great distributing center of a vast selling and purchasing community, the strength and importance of which is increasing every year.

The chief city of the State of Illinois, Chicago is practically the commercial metropolis of the adjoining States of Indiana, Kentucky, Iowa, Wisconsin, and Minnesota, all of them devoted chiefly to agricultural and pastoral industries, the products of which gravitate chiefly towards Chicago and St. Louis. The State of Illinois, which has an area of 56,650 square miles, a length of 385 miles, and a width of 220 miles, is almost wholly prairie land, the greatest elevations not rising more than 900 feet above the level of Lake Michigan; about one fourth of its whole area is devoted to the growing of corn, and $\frac{1}{12}$ to the raising of wheat, while over 4,000,000 acres are used as pasture land. Almost the whole State is a vast coal field, the area of the coal measures being computed to cover 30,000 square miles. There are about 14,000 miles of railroad in operation in this State representing a capital expenditure of more than £320,000,000 sterling. The gross income earned by this expenditure last year was £12,630,000, the net earnings being 33.10 per cent. of the total. Although figures are uninteresting and difficult to retain, it is worth while to put a few on record to illustrate the railway business in this one State of the Union during last year. The number of passengers carried was 23,755,000, and the average distance travelled was 26.25 miles by each passenger; the cost of carrying each passenger for one mile was 1.721 cents. The number of tons of freight carried was 44,931,095, and the average distance hauled was 98.43 miles, the cost of transport being .513 per cent. In this large total minerals take the leading place, the tonnage being about 14,500,000; about 10,000,000 tons represent the product of agriculture transported, 3,500,000 tons the weight of animals, 3,000,000 tons that of lumber, 4,500,000 the tonnage of manufactured articles, and nearly 4,000,000 tons the weight of general merchandise. Of course a considerable portion of this large business found its way to the stock-yards, grain elevators, and wharves of Chicago, which are,

moreover, crowded by the ceaseless flow of water-borne freight brought over the great chain of lakes from the eastward, chiefly in the form of general merchandise, or cleared from the city port towards the same direction, in the shape of cereals, meat, and minerals.

The city of Chicago is situated on the Southwestern shore of Lake Michigan, and it covers an area of 111,360 acres, or about 174 square miles. It must not be supposed that this vast extent inclosed within the city limits is yet densely inhabited, or even built over. Great tracts of virgin prairie land are included within the boundaries; the extensions of the main streets are laid out across them, but they are innocent as yet of any purpose except that of occasional grazing, or of buildings here and there put up in advance of their time by enterprising speculators or by persons with a taste for isolated residences. It is urged against the citizens of Chicago by the inhabitants of less rapidly growing American towns that, in their zeal to own the largest city in the world, they will not rest till they have fenced in the entire State of Illinois; but this stricture is hardly just, for if the growth of the population continues at its present rate, another ten years will see the greater part of the spaces now vacant closely built over. At one extremity of the city limits, and included within them, is the suburb of Pullman, once an independent town, the construction of which was commenced nine years ago, and which has to day a population of 11,000, chiefly dependent on the Pullman Company, which manufactures railway rolling stock on a very large scale. Some idea of the rapid growth of Chicago may be gathered from the fact that ten years ago it was, in importance of population, the fourth city in the Union; to day it occupies the second place, coming next to New York, with a population of 1,098,576, as compared with 503,185 in 1880. The number of inhabitants has thus more than doubled during the last ten years. This is a far larger increase than can be shown by any other city in the United States, the growth of the population of New York having been only 307,000 during the same period.

The following list gives the population of 11 of the principal towns in America, as returned by the census of 1890 and that of 1880:

Name of City.	Population 1890.	Population 1880.
1. New York	1,513,501	1,206,209
2. Chicago	1,098,576	503,185
3. Philadelphia	1,044,894	847,170
4. Brooklyn	804,377	566,663
5. St. Louis	460,357	350,518
6. Boston	446,507	362,839
7. Baltimore	433,547	332,313
8. San Francisco	297,990	233,959
9. Cincinnati	296,309	255,139
10. Cleveland	261,546	160,146
11. Buffalo	254,457	155,134

A reference to the tabular summaries of the recent census at the periods above mentioned shows that this growth is a natural and healthy one, and has not been exaggerated for the sake of effect. The increase in population of the States included in the North Atlantic division since 1873 to the present time is 40 per cent.; that for the South Atlantic division has been 50 per cent.; that for the northern central division, which includes Illinois, and is by far the most populous section of the country, 80 per cent.; in the southern central division the increase has been 60 per cent.; while in the western division, toward which a flood of population has spread, the increase has been 300 per cent.; the total figures, however, in this latter case are comparatively insignificant.

The trade and prosperity of the city of Chicago appear to have increased as rapidly as its population. In 1887 the total value of the commerce of the city was estimated at the enormous sum of 240,000,000 sterling, and since then three years of unusual prosperity must have largely swelled this amount.

(To be continued.)

New Aluminum Alloys.

The *London Engineer* says that more nonsense than enough has been talked about aluminum and its capabilities. From its earliest appearance on a semi-commercial scale, under the patronage of Napoleon III., with the eminently absurd title of "silver from clay," up to the present instant, when the most surprising mixtures for its manufacture are daily patented, it has served as the catchword and stalking horse of the ignorant enthusiast and the knavish empiric. Its wide diffusion, difficult extractibility, and remarkable properties seem to have appealed especially to that class of persons whose imaginative powers are largely in excess of their intellectual faculties, and, characteristically enough, rushing in where angels fear to tread, they have been guilty of the wildest extravagances. Struck by the low specific gravity of the metal—2.67—a cubic foot only weighing 167 pounds, and its considerable tensile strength, others, differing in degree but scarcely in kind, have advocated its use as a material of construction in place of such obsolete substances as iron and steel. A rule-of-three sum, had they condescended to work it, would have shown them that, weight for weight, its tensile strength about equals that of mild steel of moderate quality, and that concening such factors as extension and elastic limit, perhaps the less said the better. Another cause than mere thoughtlessness exists for the popular superstition about the immense strength of aluminum. The alloy which has hitherto proved the most useful of those of which aluminum forms an essential part, is that known as aluminum bronze, consisting of 90 parts of copper and 10 of aluminum; and it has been commonly confused with aluminum itself. A few years ago, if not at the present day, nine "educated" persons out of ten, if asked the color of aluminum would have replied "yellow;" a familiarity with pencil cases and simlar trinkets of that line being the basis of their information. By the convenient combination of the strength of this alloy with the density of pure aluminum, a material was obtained with an exclusively subjective existence of superlative strength and adaptability. Meanwhile the practical worker had found that aluminum itself is costly to prepare, but that its alloy with copper could be obtained by such processes as the Cowles at a reasonable cost. There is solid ground for this conclusion, inasmuch as the formation of the alloy is attended with the evolution of a considerable quantity of heat; and thus the net amount of energy that must be expended for the reduction of a given weight of aluminum is less when it is produced in the alloyed state than when free.

The abandonment of attempts to prepare a specially light material in favor of those directed toward the production of alloys of ordinary density, which might be useful on account of other valuable properties, caused the possibility of taking advantage of the great lightness of aluminum for reducing the weight of an alloy having a high tensile strength to be rather lost sight of. It is obvious that a considerable margin exists for raising the specific gravity of aluminum by alloying it with some heavier metal before it loses its claim to be considered an exceptionally light material. Quite recently experiments in this direction have been made at the department of aerial navigation for military purposes at Calais, and have been attended with an encouraging measure of success. The aluminum used was obtained from the Societe de l'Aluminum, and was very nearly pure. Copper in the form of ordinary conducting wire was used to alloy with it, the product being rolled into sheets 1 mm. in thickness. Strips having a width of 5 mm. were cut from these and tested with the following results:

Composition.		Specific Gravity.		Tensile Strength Kg. per Sq. mm.
Aluminum. Per Cent.	Copper Per Cent.	Calculated.	Determined.	
..	.	....	2.67	1.87
98	2	2.78	2.71	30.7
96	4	2.90	2.77	31.1
94	6	3.02	2.82	38.6
92	8	3.14	2.86	35.5

These figures are sufficiently remarkable; the addition of only 2 per cent. of copper is seen to increase the tensile strength from 18.7 to 30.7 kg. per square mm., while 6 per cent. more than doubles it. Another most interesting feature, and one only second in importance to the increase in strength, is the large divergence between the specific gravities of the alloys calculated from those of their constituents, and determined directly. Each 2 per cent. of copper might be expected to raise the specific gravity by 0.12, whereas the increase actually observed is only about 0.05. Thus, it results that an alloy of aluminum having double the tensile strength of aluminum itself can be made, which is less than $\frac{1}{20}$ heavier.

Of course it must not be forgotten that the experiments on which these statements are based were made on a small scale, and we have no guarantee that a material possessed of the properties quoted above could be turned out of uniform quality, and without serious difficulty as a commercial product. Further knowledge is also necessary, not only of all such properties as can be ascertained in the chemical, physical and engineering laboratory, but also of the behavior in actual practice of the alloy when subjected to those conditions almost impossible to be imitated by specified tests, which are included in the comprehensive term "wear and tear," and which occasionally condemn materials from which much has been expected. At the same time the direction of research in which these experiments have been conducted is so novel, and the results so striking, that it is to be hoped solid advantages will accrue from their prosecution.

Radiant Matter.

The name of Mr. William Crookes, *Engineering* remarks, is so indissolubly connected with researches into the behavior of the molecules of attenuated gases that it was not surprising he should take this subject as the material for his Presidential Address to the Institution of Electrical Engineers, on Jan. 15. It had the further advantage of being novel to a great many of his hearers—a very notable merit in an address of this kind. Not that it is meant that the speaker confined himself solely to the results of his latest researches, but that the phenomena with which he dealt had never attracted the serious attention of many to whom he was speaking, because they were so far removed from the problems that occupy their lives. It is well that the practical man should be occasionally reminded that his pursuits do not fill the entire intellectual horizon, and that to lay bare the secrets of nature is a joy to the philosophical mind quite apart from their immediate applicability to the material welfare of the race. Some day, when the scheme of the universe is growing complete, every atom of knowledge that has ever been gained will be found not only useful but necessary to fill up the blanks and correlate the various sciences.

Mr. Crookes' address covered a wide range, and, as intimated, it dealt in part with matters already published by himself and others, concerning the various phenomena presented when an induction spark is made to pass through a gas attenuated to various degrees. Its greatest interest was centered in that part in which the speaker defended his views against those of Dr. Puluj. This latter physicist attributes the phenomena exhibited in a vacuum tube to mechanically detached particles of the electrodes, charged with negative electricity, and moving progressively in straight lines, and not to the radiant matter of the residual molecules of the gas. To these particles he gives the name of "radiant electrode matter."

To disprove this hypothesis and to show that the phenomena are independent of the electrodes, Mr. Crookes had constructed several new forms of tubes. The first had two negative electrodes so arranged that the molecules or particles shot out from them impinged on the phosporescent glass of the tubes. One of the electrodes was of silver, a volatile metal under these conditions, and the other of aluminum, practically a non-volatile metal. In spite of these differences, and of the fact that it is known that the silver electrode wastes under the spark, there was no perceptible difference in the luminosity of the two phosphorescent spots on the glass. In a second tube a concave silver electrode had fixed opposite to it a screen pierced with a small hole through which a narrow beam of light passed on to the glass. The current was kept up for many hours until a certain portion of the silver electrode had been driven off. It was then found that all the silver was deposited in the neighborhood of the poles, and that the part of the glass which had been phosphorescing under the rays, was quite free from it. To render the matter still more striking other tubes were made without any internal electrodes whatever. In place of these the tube was silvered in places outside, the current acting through the body of the glass. In such tubes the characteristic dark space and stratifications were perfectly produced. Even mechanical motion could be produced in them by allowing the rays to fall on the vanes of a tiny wheel, which rotated in one direction or the other, according to the way the current was directed. These experiments effectually demonstrated that the presence of metallic electrodes within the tube was not essential to the production of the various phenomena. To show that the glass over the electrodes did not throw off particles, Mr. Crookes made a tube of lead glass phosphorescing blue. Two silver electrodes were formed on the outside of the globe, which was painted on the inside, beneath the negative electrode, with a coat of yttria, which phosphoresces a golden yellow. It is argued that if particles of this earth were torn off and hurled across the globe they would show their distinctive color, while, in reality, the blue light of the glass was only to be seen. This experiment seems to go far to uphold Mr. Crookes against Dr. Puluj. It is quite conceivable that the glass coverings of the electrodes might suffer the expulsion of their particles as easily as the metal electrodes themselves, but it would be extraordinary if the glass were projected through the layer of yttria without carrying with it some of the earth. Of course it yet remains to be proved that the infinitely small quantity of yttria that could be projected under the most favorable circumstances, would show a glow, but there is strong reason to suppose that it would.

Another most interesting point that Mr. Crookes sought to elucidate was the path followed by the molecules after they have been shot away from the electrode. As radiant matter is supposed to move in approximately straight lines, and in a direction almost normal to the surface, the supply of gaseous molecules would run short if they did not find some means of getting back. To demonstrate the course of the stream there was exhibited a most beautiful and delicate experiment, which evoked the admiration of all who saw it. In the middle of a tube was a diaphragm cutting it into two parts. This diaphragm was pierced with two tiny holes, opposite each of which was a wheel with vanes against which molecules passing through the aperture must impinge. A convex electrode shot particles of the attenuated gas through one hole in the diaphragm, and on to the wheel, putting it into rotation. Soon after, the second wheel got into rotation, showing that there was a current through the second hole in the diaphragm back into the part of the tube containing the electrode, and that this current had sufficient energy, after it had passed the diaphragm, to move the wheel. This tube had been exhausted to a pressure of $\frac{1}{1000}$th of a millimeter of mercury, and at this high exhaustion a stream of molecules issued from the lower hole in the diaphragm, whilst at the same time a stream of freshly charged molecules was forced by the negative pole through the upper hole. Mr. Crookes was careful to state that this ultra gaseous state of matter was advanced merely as a working hypothesis, which might be regarded as a necessary help, to be retained only so long as it proved useful. Such conceptions are a great aid in research if they are not held to tenaciously. It is quite possible to become more zealous in defence of a theory than in the pursuit of truth.

The phosphorescence of bodies in a vacuum tube varies with the position that is given to them. With yttria the point of maximum phosphorescence lies on the margin of the dark space, and decreases steadily as the body is moved back towards the positive pole. Bodies will, however, exhibit a temporary phosphorescence while in actual contact with the negative pole. If an aluminium pole be painted with phosphorescent yttria and the exhaustion of the tube gradually effected, the pole becomes finally phosphorescent as the rarefaction approaches a pressure of .5 millimeter. As the exhaustion proceeds the phosphorescence diminishes in intensity, and at the same time contracts in area, leaving the edges and receding towards the center of the pole. This would seem to point to the fact that the discharge takes place from the center of the electrode at high degrees of exhaustion. When the negative pole ceases to be luminous the positive pole commences to light up, increasing in intensity until the tube ceases to conduct. This phenomenon is referred by Mr. Crookes to the action of "vagrant" molecules, which having been shot away from the negative pole happen to come within the influence of the positive pole, and being attracted, rush violently up to it, exciting the phosphorescence of the yttria. To demonstrate the presence of these vagrant molecules, the speaker employed a very ingenious piece of apparatus, consisting of a U-shaped tube, with a pole fused into each end. In each leg of the tube there was fixed a mica screen, parallel with the axis and covered with phosphorescent powder. Molecules sent out from the negative pole exactly normal to its surface would move parallel to the screen, but if they followed a path at all divergent, as they always do, many of them would strike it and excite the phosphorescence. To further regulate their course a small screen, with a tiny hole in it, was placed at right angles to the first, cutting off the greater part of the stream of molecules, and only allowing those to pass that were nearly parallel to the main screen. At an exhaustion of .076 millimeter a bright phosphorescent line was created on the screen in front of the negative pole, while the screen in front of the positive pole remained dark. But at a point of exhaustion just short of non-conduction (.000076 millimeter) the light became unsteady on the negative screen, while the screen in the leg of the tube opposite the positive tube began to light up. This screen had its directing aperture at the end remote from the pole, so that molecules which had passed from the negative pole over the first screen, and had then turned up the other leg of the tube towards the positive pole, were cut off unless they were in the center line of the tube. But in spite of this precaution the molecules did not follow a straight path up the screen to the pole, but diverged to the right and left so much that the result was a star of phosphorescence on the screen, and not a beam. It was evident that the molecules were not moving under a strong directive influence, they were wandering idly with no settled purpose, they had been violently hurled away from the negative pole, and were surging back from side to side, like the waters of the sea the day after a storm.

THE Directors of the Fortville Natural Gas and Oil Company, of Columbia City, Ind., have ordered the cutting-off of all flambeaux-jets, and will no longer take contracts to supply gas to manufactories for fuel purposes. The reason for the order is that the Fausset well (when drilled 18 months ago it yielded a flow of 3,000,000 cubic feet per diem) has completely failed. The Company's other wells have diminished in output some 30 per cent.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. J. K. HONEYWELL, Secretary of the Lincoln (Neb.) Gas Company, writing under date of Feb. 3, says: "At the annual meeting of the stockholders of our Company the following Directors were elected: D. E. Thompson, C. W. Mosler, R. C. Outcalt, H. J. Walsh, and J. K. Honeywell. The Directors were instructed to remove the works this season to more commodious grounds, and to erect thereon a boiler room 44 feet by 80 feet, an engine room 72 feet by 100 feet, a generating room 35 by 40 feet, and a purifying house 36 feet by 95 feet. They were also ordered to lay 27,000 feet of pipe the coming year, mostly 12 inch and 10 inch diameters. So, you see, we are trying to keep pace with the growth of the city."

A BILL to incorporate the Mount Airy (N. C.) Light and Power Company is before the State Senate. This place is a post village of a similarly named township in Surry county, North Carolina, on the Ararat river at a point 90 miles north of Charlotte. It is quite prettily situated, is a thriving place, and holds a population of perhaps 4,800 souls. It is likely that the Company will try electric lighting at the outset.

THE Newport News (Va.) Company has been chartered, with a wide range of objects. The most important, however, of these is to establish a works for the "manufacture and distribution of gas or electricity for heating, illumination, and power." The capital stock (maximum) is put at $250,000, and the officers are: President, V. D. Groner; Vice-President, D. C. Hipkins, New York; Secretary, John C. Mason; Treasurer, Thomas A. Young, New York; Directors, V. D. Groner, D. C. Hipkins, John C. Mason, Thomas A. Young, I. H. Chardink, D. D. Elder, Robert Wolfenden, I. A. C. Groner, Solomon Hamburger, Wm. Wilson, and M. T. Hughes.

SOME time ago we noted the establishment at Norwich, N. Y., of an experimental plant of the Knapp-Cambell process type, and in continuation of its history we have to say that the plant has been sold to the Excelsior Chemical Works, of Newark, N. J. The last chapter would seem to indicate that the Knapp Campbell system is not altogether a success.

DESPATCHES by way of Chicago, dated the 5th inst., are to the effect that the purifying house of the Eau Claire (Wis.) Gas Company was badly wrecked by an explosion that morning. The damage is put at $3,000.

THE people of Cincinnati—that is, if the "yawping" of a certain coterie of the officials of the American Paris is to be taken as their voice—yearn for better street lighting, and threaten to go into the arc system on an imposing scale. In the meantime they declaim over the excessive cost of maintaining the public gas lamps, and in the next breath blow cold in respect to the saving that would be effected were electric lighting to become the rule and not the exception. Electric lighting specifications have been arranged, however, and there is where the hollowness of the "public's voice" is apparent. General Hickenlooper has been "taking it all in," and, as is usual with him, he chose a very opportune time to put a few facts before the Committee on Light, respecting the question in hand. The General having explained that Cincinnati is now expending less for lighting its streets than was the case 18 years ago, notwithstanding the fact that the number of lamps maintained to-day is almost double the total of 1873, shows that this advance has been obtained simply and solely by the pronounced reduction in gas rates as between the extreme periods. [The expenditures in 1873 on this account equaled $235,276, whereas in 1890 the disbursement was but $185,000.] Continuing, the General said: "Nor does it appear that the volume of light provided has ever been increased in the city since gas lighting was first established, so that our forefathers fared much better than we do now, because of the increased demand for a better illumination, due to constantly increasing use of soft coal, which darkens and makes dense the atmosphere in the basin, or lower levels of the city. Having argued that a proportionate expenditure would now warrant the appropriation of $400,000 instead of $185,000, he asserts that to light the city with electricity, in accordance with the samples at present maintained on Fourth street, would require an appropriation of $2,500,000 per year—the annual cost of lighting with electricity, as per the specifications arranged, would not be less than $1,000,000—whereas the illumination by gas would be increased to six times its present volume throughout the lower levels, from the river to the hills, for an additional sum of $42,000 per annum." In conclusion the General remarked: "From what I have stated in the foregoing, in regard to the former and present cost of lighting our streets, it must be apparent to all that the deficiency of light upon our thoroughfares is due entirely to the apparently uncalled-for restriction in the expenditure for this purpose." As usual, the General seems to have the better of the argument.

AT a recent meeting of the Philadelphia Councils Committee on Gas, the special matter for consideration was the ordinance introduced by Mr. W. A. Miller to reduce the price of gas to ordinary consumers from $1.50 to $1 per 1,000 cubic feet. Director Wagner made the following argument against the proposition: "The public is misled in the belief that the city is making an enormous profit out of the sale of gas, which belief is largely influenced by the fact that it paid only 37 cents per 1,000 cubic feet for the water gas made at the Twenty-fifth ward works. Last year the entire output of gas amounted to 3,311,000,000 feet. Of this 2,177,000,000 feet were bought by the city for 37 cents per 1,000, and 1,134,000,000 were manufactured by the city at a cost of 60 cents per 1,000, making the average cost of all the gas to the city 52 cents per 1,000. Now, if this were the only expense the city could very readily sell its gas for $1 per 1,000 and make money. But you must consider how much of this gas is actually paid for, how much is lost by leakage, the cost of extensions to the works, and the expenses of distribution and repairs. To get the gas out of the holders and into the meters costs 18 cents per 1,000 feet, an increase in the cost to the city that brings the rate to 70 cents. Then we are compelled to make extensions each year to the works, and so on, the cost of which is a proper charge to manufacturing account. Last year this item averaged 14 cents per 1,000 feet for the gas used, increasing the cost of gas to 84 cents, the price at which it was put into the people's houses last year. If the city could sell all its gas for this price it could still make a profit at $1 per 1,000 feet, but we only sell 72 per cent. of all the gas made. Of the 3,311,000,000 feet made last year, we got cash for only 2,227,000,000. Now, what became of the rest? We furnished the Bureau of Police with 13,000,000 feet; the Bureau of Fire with 8,698,000 feet; the Bureau of Water with 2,400,000 feet; the Public Buildings with 19,821,000 feet; the Almshouse with 14,275,000 feet; the Bureau of City Property with 4,900,000; the public squares with 7,300,000 feet; the Park Commission with 3,000,000 feet; the schools with 7,700,000 feet; the street lamps with 472,000,000 feet. For this large amount of gas we never get a dollar. If Councils in their wisdom would appropriate money to the departments to pay for the gas they use they would be more careful and the amount would be considerably diminished. Besides the gas used by the departments, there is lost, through condensation and leakage, about 13 per cent. of the total amount manufactured. In other words, we cannot account for about 400,000,000 feet on the total output, therefore we realized $1.10 per 1,000 feet. The cash receipts of the Gas Bureau last year were $3,659,000; the expenses were $2,806,000, leaving a profit of $853,000. Now, suppose the gas was sold for $1 per 1,000 feet, our receipts would have been $1,130,612 less than they were, and we would have a deficit of $277,612 instead of a profit of $853,000. How are you going to make that up?" When the Director's side of the argument had been received, no one present seemed disposed to advocate the ordinance, and, on motion of Select Councilman McMurray, it was unanimously agreed to report the bill back to Councils with a negative recommendation. There is no doubt, however, that the matter will be argued at length before Councils, with the likelihood that a compromise figure, not far from $1.25 per 1,000, will be agreed upon.

GENERAL MANAGER RUNNER, of the Freeport (Ills.) Gas Light and Coke Company, and of the Freeport Electric Light Company as well, writes us that the City Council has concluded a contract with his Company, under which the latter is to furnish the city with 60 public arcs, the agreement to last for ten years, and to date from the expiration of the present five-year contract, made in March, 1886. Under the last contract only 45 lights were taken, and from the increase to 60 lights, on a ten-year agreement, too, it would seem that the authorities are very well satisfied with the service hitherto rendered by the Company. President Farwell and General Manager Runner are a very clever pair of business men.

THE Concord (N. H.) Gas Company has just placed contracts for a new purifying house, 60 feet by 38 feet, in which a set of four boxes will be placed; and will also install two large boilers and a 225-horse power Reynolds-Corliss engine.

SOME days ago the County Commissioners of Toledo, Ohio, received a bill for lighting services rendered by the local electric company, on account of incandescent lamps in the public buildings, and our advices are to the effect that the Commissioners considered it out of all proportion to the quantity of illumination yielded. One of them went so far

as to say that the lamps ought to be taken out of the Court House, the officials in that building having unanimously voted that gas was much superior. Gas has frequently been called upon to supplement the efforts of the incandescent lamps, and the renewals account in respect to lamp bulbs is a matter of serious import.

REFEREE HENRY J. SCOTT has filed his report in the suit of John Fischer against the city of Philadelphia, in which he awards complainant the sum of $1,488.88. Fischer is the owner of the premises 2,415 and 2,417 Wright street, Philadelphia. On the morning of June 17, 1889, an employee of the Gas Bureau was instructed to turn the gas off at 2,427 Wright street, but the workman went to 2,417 Wright Street, and instead of shutting the gas off there turned it on. The occupants of the house were all out at the time. A service pipe led into 2,417 Wright street, but as the occupants were not using gas at the time, there was no meter in the cellar, and the service at the cellar end was uncapped. The gas filled the cellar and eventually found its way to the kitchen range, in which a fire was burning. The explosion that followed damaged the house in the sum named by the referee.

WE are indebted to a La Crosse (Wis.) correspondent for the following interesting notes: "The Twenty-eighth Annual Meeting of the La Crosse Gas Light Company was held in the Company's office about the middle of January. The old officers were re-elected as follows: President, James Vincent; General Manager, G. W. MacMillan; Secretary and Treasurer, G. W. MacMillan. The Manager's report of the transactions of the corporation in 1890 was satisfactory to the shareholders. The Directors declared a dividend of 2 per cent., payable January 31st. The following alleged extract from the Manager's report may be of general interest: 'The average rate received for all gas manufactured in 1890 was 15 cents a thousand less than *cost* in 1885. * * * During 5 years ending December 31st, 1891, the quantity manufactured was increased 39 per cent.; the cost of manufacture was decreased 56⅔ per cent.; the average selling price was decreased 38 per cent.; and the earnings of 1890 were 11⅓ per cent. more than the annual average of the period under review.'" Quite a record, that.

The highest price ever made in the shares of the Norfolk (Va.) Gas Light Company was recorded a few days ago, when 10 shares were sold at auction at $172.50 per share. The purchaser afterwards said that $175 per share was his limit.

AT the annual meeting of the Somerville (Mass.) Electric Light Company, the President (Rev. E. H. Capen) refused a re-election either as President—he has held that office since the organization of the Company—or Director. Mr. George B. Neal, of the Charlestown (Mass.) Gas Company was elected to the vacancy.

AT the annual meeting of the Washington (D. C.) Gas Company the following officers were chosen: President, George A. McIlhenny; Secretary, Charles B. Bailey; Treasurer, John C. Poor; Assistant Secretary, Wm. B. Orme; Directors, Geo. A. McIlhenny, John C. Bullitt, Wm. B. Webb, W. R. Riley and James W. Orme.

A CORRESPONDENT at Richmond, Va., writing under date of the 7th inst., forwards the following: "Quite a number of persons in this city are of the belief that the city, under its charter, cannot prohibit electric light companies from furnishing electric light to private consumers, when the municipal plant is put in operation. Last February, when the Richmond Railway and Electric Company asked the Legislature for its charter, representatives of the city proposed an amendment to the bill providing that when the city should establish an electric plant then the right of the Company to sell light to private consumers should cease. The representatives of the Company accepted this amendment, as its attorney knew at the time that the city had no right under its charter to make such a prohibition, and that the amendment would come to naught unless the charter was amended. A few days after the bill incorporating the Company was passed, Mr. W. Dean Courtney, Chairman of the Council Committee on Electric Light, prepared a bill amending the city charter to meet the case, which measure was adopted in General Assembly and signed by the Governor. The Electric Light Company, strange to say, knew nothing about this matter until some time after it became a law. The opinion of eminent legal talent now is to the effect that when the city plant is in readiness to supply electric currents to private consumers the City Council has the authority to order all independent electric companies to stop their sale of currents, and to restrict them to the use or generation of such currents on their own domestic account."

THE Electric Lighting Companies of Buffalo, N. Y., have been notified that tests of the arcs supplied by them under public contract on the city's streets are to be made at regular intervals by the City Chemist, Professor Vandenbergh. The Chemist's offices have been fitted up with a very complete set of apparatus for determining the candle power, etc., of the lights, and his report will be looked forward to with interest. The companies, however, are striving for delay.

IN respect to the testing apparatus set up by Professor Vandenbergh—his offices are centrally located in the city—it might be well to remark that the original intention was, according to the Councilmanic idea, to test the arcs at given points in the city, but the Professor thought it would be more in accordance with fairness and accuracy to have the current brought into his laboratory over a wire from the street circuit, then to take the specimen lamps from the street points and test the same in the laboratory, where a thorough examination could be made. His argument was concise and amusing and convincing. Summed up, it was about like this: "It is all right to support a portable apparatus on a sawbuck, set it up on a sidewalk, take a squint at an electric lamp and guess that it is about 1,200 or 1,500 candle power. I object to making any such test, and to sign any statement resulting from it, for the work cannot be properly done."

AT the first annual meeting of the Charleston (West Va.) Gas and Electric Light Company, which is a consolidation of the local gas and electric lighting interests, the following officers were chosen: President, E. B. Knight; Secretary, W. S. Laidley; Treasurer, Ph. Frankenberger; Superintendent, O. H. Michaelson; Directors, Frank Woodman, Ph. Frankenberger, E. B. Knight, O. H. Michaelson, W. S. Laidley, Chas. H. Taney and Henry S. Walker.

MR. JAMES B. HOOPER, for many years Superintendent of the Media (Pa.) Gas Company, died at his residence in that city, on the 1st inst. He was born in York, Pa., about 42 years ago. Interment was made at York, on the 5th inst.

A SUBSTANTIAL reduction in rates has been made by the proprietors of the Las Vegas (New Nexico) Gas and Coke Company.

MR. NOHL, of Cook county, Ills., has introduced a bill in the State Legislature which seeks to prohibit electric lighting companies "from charging their wires with a current exceeding 1,000 volts." The prohibition is not to extend to companies that have their wires underground.

THE Clark Bros. have filed an execution (amounting to $6,787) against the West Jersey Electric Light, Power and Heat Company, of Merchantville, N. J.

MR. JAMES FERRIER, Superintendent of the Eufaula (Ala.) Gas, Electric Light and Power Company, writing under date of February 7th, says: "We have been in the electric lighting business since October, 1889, although it was not until the beginning of last year that it commenced to displace gas to any serious extent. In January and February of 1890 many of our best consumers put in electric lights and almost wholly discontinued the use of gas. Despite this fact, however, I have to record that the private consumption of gas for 1890 exceeds that for 1889 by 12 per cent. I am looking forward to the May meeting. * * *."

THE Board of Directors of the New Orleans (La.) Gas Light Company organized by electing the following officers: President, A. H. Sieverd; Vice-President, R. M. O'Brien; Secretary, V. Vallois; Treasurer, F. E. Richmond.

MR. GEORGE H. BROWN has been appointed General Manager of the Philadelphia Gas Company, vice Mr. Frank Wilcox.

THE Voss *Gazette*, of Berlin, published, in a late number, some interesting figures respecting the growth of electric lighting in that city. According to its statement there are at present in use there about 5,000 arc and 80,788 incandescent lamps, the increase during the past year having been 1,166 arcs and 17,912 incandescents. The bulk of this business is in the hands of the Berlin Electric Company, which supplies 1,832 arc and 43,215 incandescent lamps, while the remaining 3,112 arcs and 37,573 incandescents depend on 262 isolated plants, driven by 171 steam engines and 91 Otto gas engines. These figures, while illustrating the steady growth of electric lighting in Berlin, are also remarkable for the large number of isolated plants, and it must be interesting to our gas men to note the important part played by the gas engine in this field. This successful competition brought by the gas interests against the central station electric lighting interests can certainly be duplicated in our

large cities, particularly if the impetus afforded by the Berlin Gas Company to the movement is given here. The Berlin Gas Company sells gas for power purposes at a pronounced concession from the rate charged for lighting—about 85 cents per 1,000 cubic feet, or something like a rebate of 20 per cent.

A PRACTICAL electrician, speaking of the prevailing craze for the interchangeable electric and gas bracket or chandelier, says: "Of course it is convenient to have the gas all ready for use if the electric apparatus gets out of order, and in theaters and public institutions the joint fixtures are particularly useful, no doubt. But I think where the double fixtures are used in hotels or private houses the taps ought to be made conspicuously distinct—in fact, it would be well to have the gas tap screwed up while the electric light is being used. The other day two actresses came very near being suffocated in a Pittsburgh hotel, through the double fixture trap. When they went to bed one of them tried to turn out the electric light. She did turn a tap, but it did not shut off the light. Then her companion got up and turned off the electric light. But the first girl had turned on the gas when she thought she was turning off the electric light. Result, two young women in a state of asphyxiation next morning, would have been dead had not their room been very large. It is a mistake quite likely to occur, and those who have double fixtures should take care in time."

THE authorities of Beverly, Mass, will receive proposals for the public electric lighting of that place, the contract to be made either on a 5 or 10 years basis. The competition will close on February 25.

FROM the annual report of Superintendent W. J. Murphy, of the Grand Forks (N. D.) Gas Company, the following figures are obtained: Total output, 10,751,410 cubic feet; 1889, 8,510,400 cubic feet. Sales to ordinary consumers, 1890, 8,625,000 cubic feet; 1889, 6,503,400 cubic feet; to the city for street lighting, '90, 1,477,400 cubic feet. The unaccounted for gas amounted to but 5 per cent. of the total make. The total receipt for the year was $22,809.89, of which $19,705.93 was received from private consumers, and $3,103.96 was received from the city on account of street lighting. The average receipt for gas sold through meters was $2.28 per 1,000, and the average on gas paid for by the city was $2.10 per 1,000. The grand average rate was $2.12 per 1,000. Average cost of gas in holder—raw material and labor in manufacture and purification alone charged up—75 cents per 1,000. The interest charge amounts to 49 cents per 1,000; taxes, 12 cents per 1,000; general salaries 26 cents per 1,000; general expenses, 18 cents per 1,000. The Company will enlarge its plant this season.

MR. A. H. BARRET, of Butte City, Montana, has applied to the authorities of Bozeman for the right to establish and operate a gas works. The people are anxious that he should be successful. Barret proposes to put up a 10-inch works.

THE public electric lighting contract this year at Reading, Pa., calls for the maintenance of 500 incandescents and 200 arc lamps. The former are to be of the 20-candle variety, while the latter are to be of the 2,000-candle, "nominal," sort. Rates, $120 for arcs, $22 for incandescents.

THE Central Ohio Natural Gas and Fuel Company, which supplies Columbus, O., recently drilled in a "gusher," at a point about 2 miles north of Lancaster, on the Glenville road, and 3 miles from the other wells. President Deshler says that the well cost the Company about $35,000, as 6 others were drilled in without striking gas. He further said that the Company had not decided whether the gas will be turned on again at Columbus or not. The Company has discharged all the drillers, sold off its apparatus and shut up shop so far as further drilling is concerned.

GEORGE H. POMEROY, President of the Litchfield (Ills.) Electric Light and Power Company, died at his home, in that city, on the morning of the 6th inst. He was in his 54th year.

JOHN HANLON, who for several years acted in the capacity of Collector for the Geneva (N. Y.) Gas Light Company, died suddenly on the 4th inst. He was in his 35th year, and was deservedly esteemed.

THE Santa Ana (Cal.) Gas Company reports a shipment of coke to San Bernardino, Cal., at a paying figure.

AN ordinance pending in the City Council, of Roanoke, Va., which sought to authorize the issue of $15,000 bonds, to be used in constructing an electric light plant to be operated on municipal account, was rejected.

MESSRS. Asher, Taylor, Stratton, Greene and others have applied for a charter under which they propose to operate the People's Fuel and Gas Light Company, of Memphis, Tenn. They will try fuel gas with the Fahnehjelm comb, provided the franchise is secured; and there is great doubt that the authorities will answer their appeal affiirmatively.

The offices of the Brookline (Mass.) Gas Light Company have been removed to No. 1 Beacon street, Boston.

AT the annual meeting of the West Chester (Pa.) Gas Company the following officers were chosen: President, Dr. Jesse C. Green; Directors, Major L. G. McCauley and Messrs. Henry Buckwalter, H. B. Buckwalter, J. B. Gray, C. S. Bradford, and Bentley Worth.

California Coal Supply.

Mr. J. W. Harrison has compiled the following respecting the coal trade of California in 1890:

This has proved a very profitable year to all engaged in this trade, especially to the owners of the coast collieries, as the ruling figures for the past six months have left them a very handsome margin over the cost of production. To evidence how marked have been the fluctuations during the year, spot cargoes of Australian coal changed hands in January last at $6.75 per ton, some cargoes of a similar grade were sold last month at $11.50 per ton, and only a limited quantity was procurable at that figure. These exceptionally high figures were not the result of any combination or trust among the dealers—simply the demands exceeded the supplies. From May 15th to September 10th no coal was shipped from the Wellington mine, and from August 25th to November 10th no cargoes were loaded in Australia. With these two principal sources of supply cut off, and at a season of the year when most in demand, the increase of values can readily be explained. The labor troubles having been amicably settled, shipments are now coming forward freely and values are declining, English and Australian cargoes being offered at lower rates for future delivery.

The following table of prices will show the monthly fluctuations of foreign coals for "spot" cargoes—the average price being given for each month:

	Australian Gas.	English Steam.	Scotch Flint.	West Hartley.
January	$6.75	$8.00	$8.50	$9.00
February	6.75	7.75	7.75	8.50
March	7 12	7.62	8.00	8.50
April	7.50	7.75	8.00	8.50
May	7.50	7.75	8.00	8.50
June	7.62	7.75	8.00	8.50
July	7.85	8.00	8.25	8.50
August	8.50	8.37	8.75	9.00
September	9.00	9.25	9.50	9.75
October	10.00	10.00	10.50	11.00
November	11.50	11.25	11.50	11.75
December	11.00	10.50	10.50	11.00

The various sources from which we have derived our supplies are as follows:

	1889.	1890.
British Columbia, tons	417,904	440,571
Australia	408,032	194,725
English and Welsh	32,890	33,145
Scotch	12,727	1,610
Eastern (Cumberland and Anthracite)	18,950	31,950
Franklin, Green river and Cedar river	209,137	216,760
Carbon Hill and South Prairie	165,377	191,109
Mount Diablo and Coos Bay	87,600	74,210
Japan	1,340	13,170
Totals	1,351,957	1,197,250

To insure a correct statement of the consumption of the State, I have included all the arrivals at San Pedro, 70,954 tons, and San Diego, 52,358 tons.

As the freight from foreign ports is the principal factor in establishing coal values, it is a query how our market will shape itself in 1891. A seasonable rainfall, producing bountiful crops, assures us a large influx of vessels that will be principally coal carriers. This, of course, signifies low priced fuel, but the season is not sufficiently advanced as yet to hazard an opinion. Notwithstanding we are now receiving 75 per cent. of our coal from our coast mines, the local agents of the northern collieries regulate their prices by the import cost of foreign grades.

The imports of foreign coke for the year amount to 18,309 tons, as against 21,624 tons last year.

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MONDAY, FEBRUARY 16, 1891.

The Market for Gas Securities.

Consolidated showed pronounced strength during the week, and opened to-day (Friday) at 98⅜ to 98½, although the actual number of transactions was small. On Thursday no sales were reported. The inference is plain—at least so it seems to us—that Consolidated will shortly be at and beyond the par mark. Equitable is more inquired after, but the difference between the estimates of bidders and sellers are still too far apart to admit of much business being done in the shares. Brooklyn quotations are steady and regular, to strong. Chicago gas was even during the week; opening quotations to day were around 40 to 41, with no marked symptoms either one way or the other. A late special to the Kiernan News Company says that at the annual meetings of three subsidiary companies of the old Trust (the Consumers, Lake and Hyde Park) the Cummings-Kent party were retired, and the New York interest replaced them. It seems to us that Chicago gas is a purchase just now. Baltimore Consolidated is at 48 to 48½ and is fairly well held. Bay State common is at 61, with a likelihood that a short sale might bring some profit, solely on account of the present measures affecting its interests that are talked about at the State House. Eastern shares are being inquired for in this vicinity.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 WALL ST., NEW YORK CITY.

FEBRUARY 16.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	98⅜	98½
Central	500,000	50	—	85
" Scrip	220,000	—	95	100
Equitable	4,000,000	100	114	116
" Bonds	1,000,000	—	113	115
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	116	120
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	—	48
Preferred	5,000,000	100	—	90
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	116	118
Citizens	1,200,000	20	85	90
" S. F. Bonds	320,000	1000	100	103
Fulton Municipal	3,000,000	100	130	132
" Bonds	300,000		104	105
Peoples	1,000,000	10	90	92
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	1,000,000	100	103	105
Nassau	1,000,000	25	130	—
" Ctfs	700,000	1000	95	100
Williamsburgh	1,000,000	50	130	132
" Bonds	1,000,000	—	108	112
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	—	87
2d " " "	3,000,000	1000	—	75
Bay State Gas Co.—				
Stock	5,000,000	50	—	60½
Income Bonds	2,000,000	1000	95½	—
Buffalo Mutual, N. Y.	750,000	100	90	95
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
" " Bonds.	45,000	—	—	—
Chicago Gas Company.	25,000,000	100	40½	40⅝
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	84¾	85½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	98
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	100
2d "	2,500,000	1000	94	98½
Consumers Gas Light Co., Jersey City	2,000,000	100	12	15
Bonds	600,000	1000	70	75
Cincinnati G. & C. Co.	6,500,000	100	204	205
Consumers Toronto	1,000,000	50	190	200
Central, S. F., Cal.			92	100
Capital, Sacramento, Cal			58	
Consolidated, Balt.	11,000,000	100	—	48½
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	110
Bonds	250,000		—	—
East River Gas Co., Long Island City	1,000,000	100	100	105
Bonds	500,000	100	100	102
Hartford, Conn.	750,000	25	102	108
Jersey City	750,000	20	165	170
Louisville, Ky.	2,570,000	50	125	130
Little Falls, N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Laclede Gas Light Co., St. Louis, Mo.—				
Common Stock	7,500,000	100	18	19
Preferred "	2,500,000	100	55	60
Bonds	9,034,400	1000	81	81¾
Montreal, Canada	2,000,000	100	200	208
Memphis (Tenn.) Gas	750,000	100	40	—
" Bonds.	240,000	100	103	—
New Haven, Conn.		25	200	—
Oakland, Cal.			34¼	35½
Peoples, Jersey City		—	60	61
" " Bonds.			—	—
Paterson, N. J.		25	99	102
Rochester, N. Y.		50	99	100
Syracuse, N. Y.	500,000	25	—	—
San Francisco Gas Co.				
San Francisco, Cal.	10,000,000	100	58½	59
Washington, D. C.	2,000,000	20	200	208
Wilmington, Del.		50	88	90

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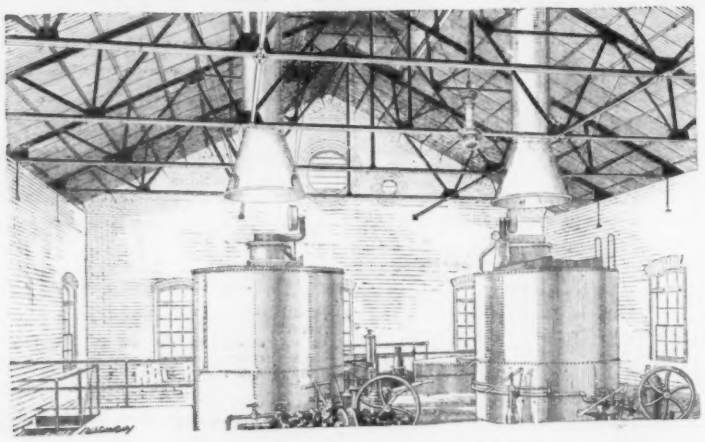

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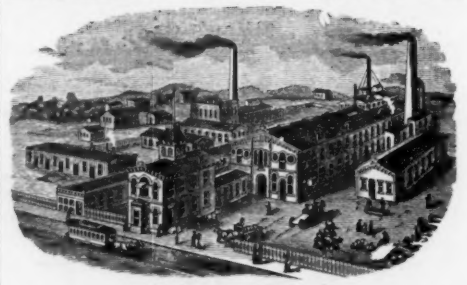

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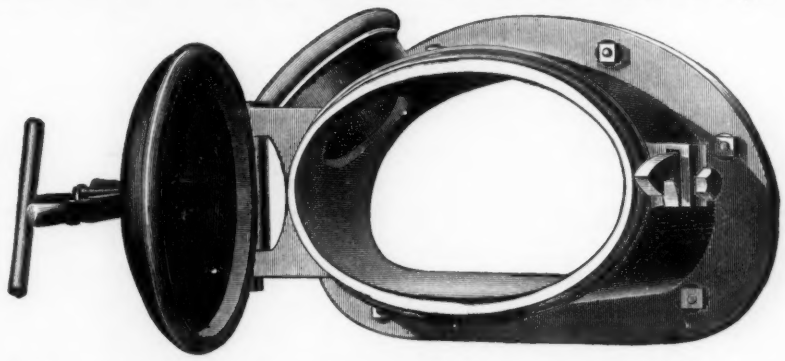

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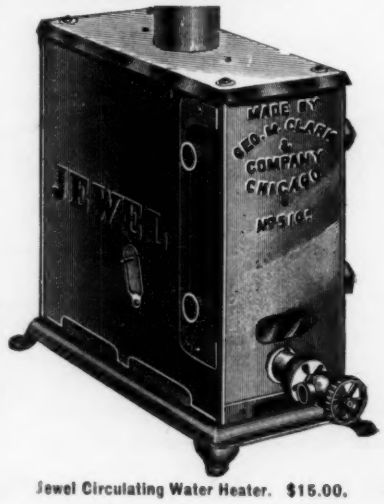

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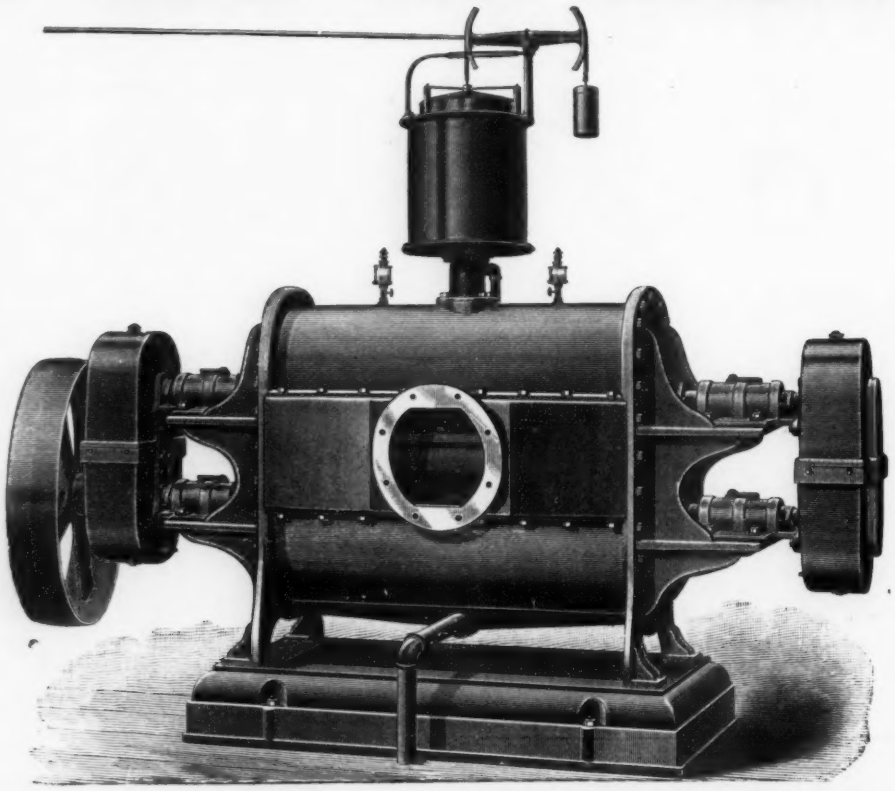

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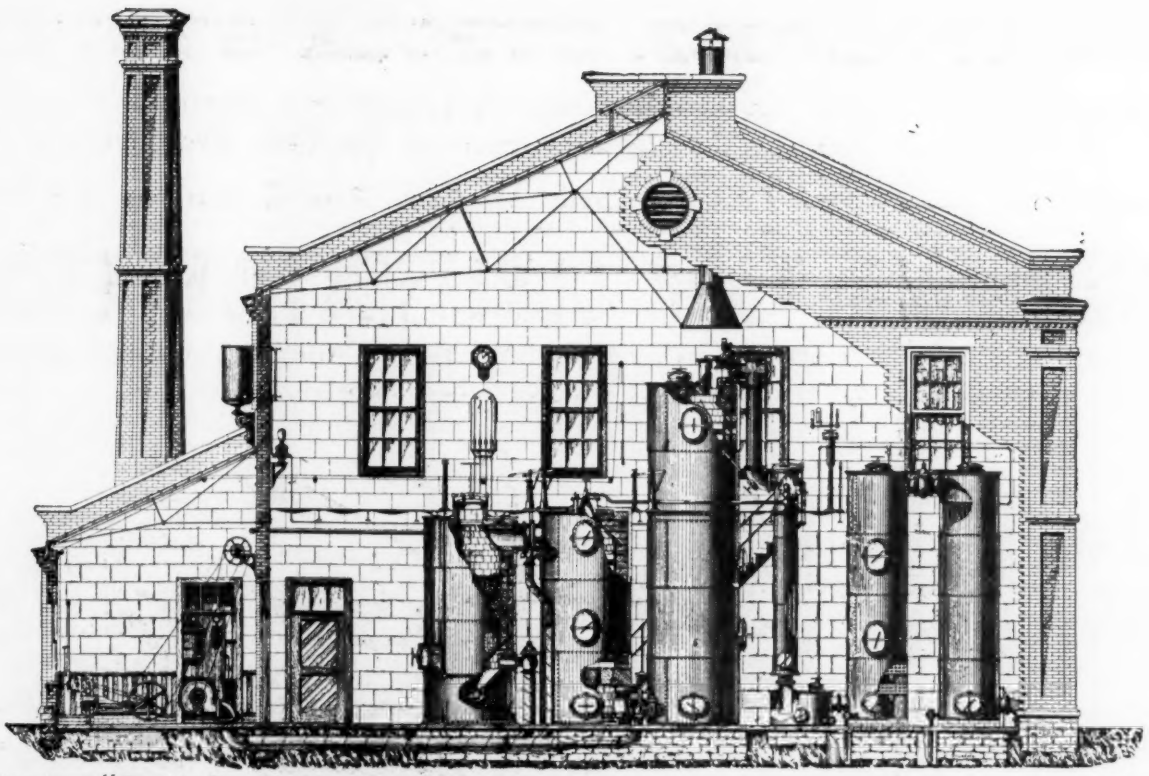

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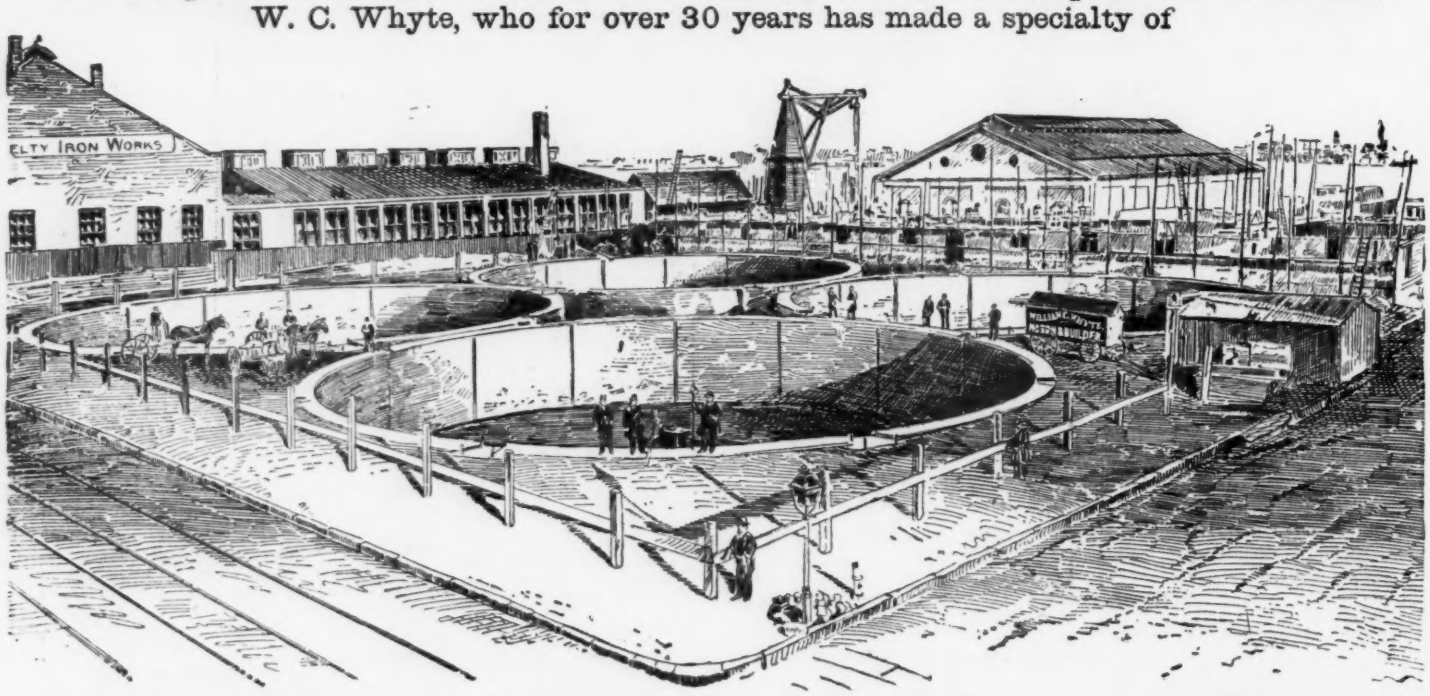

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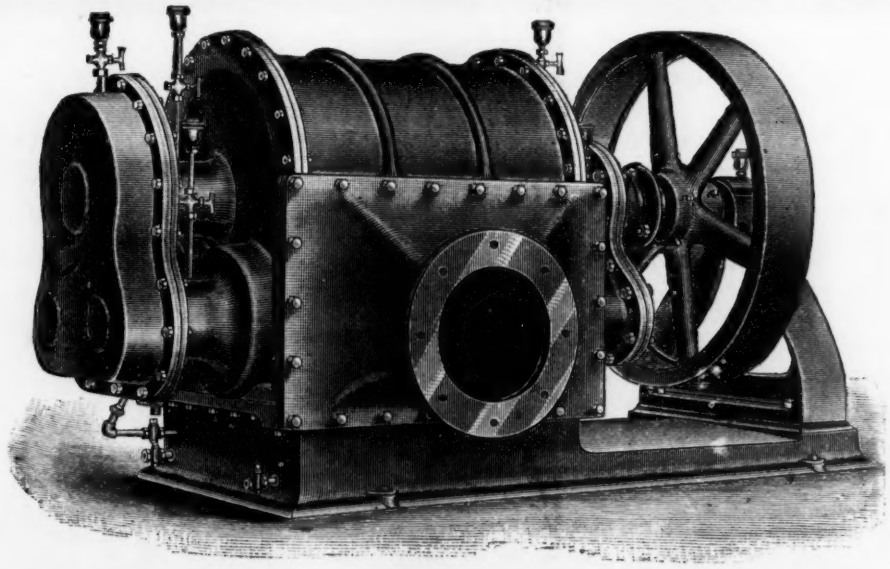

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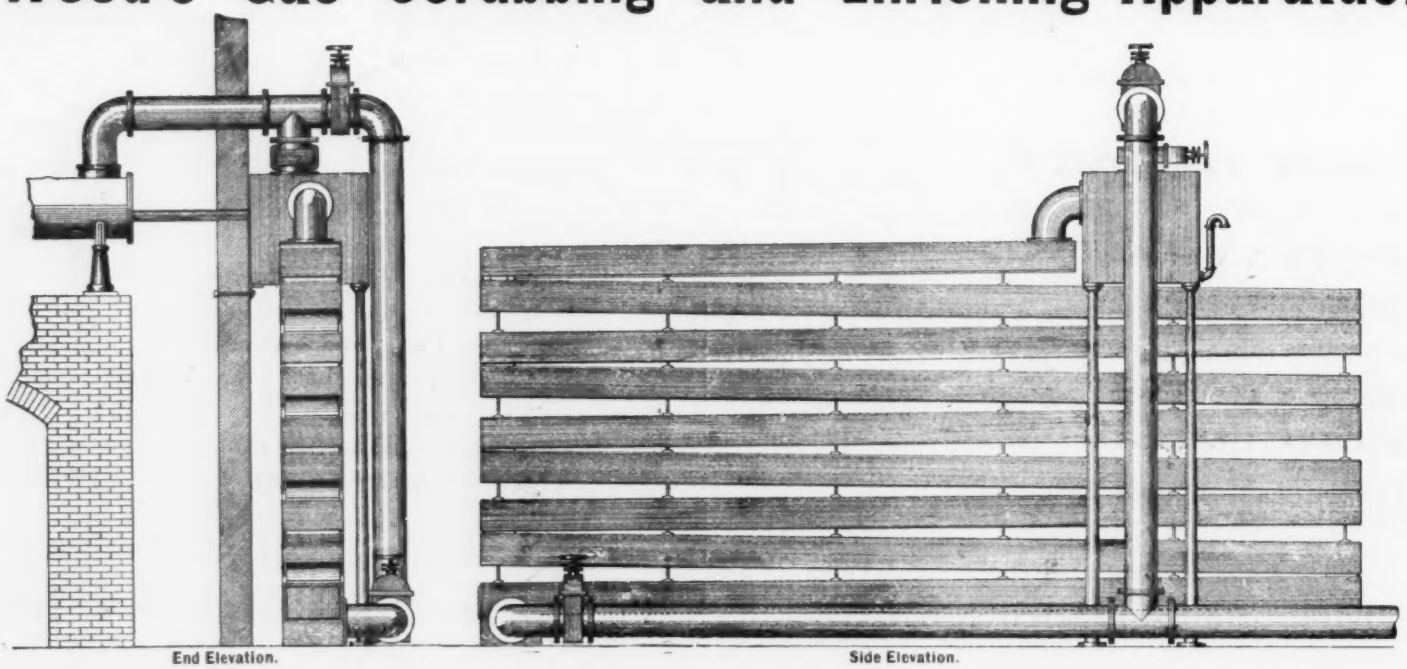

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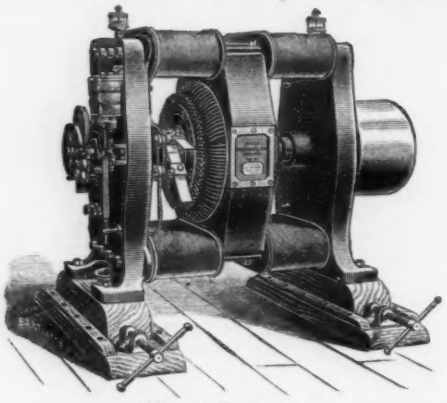

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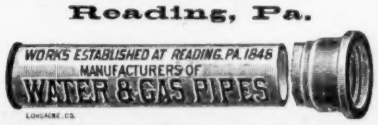

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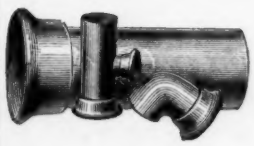

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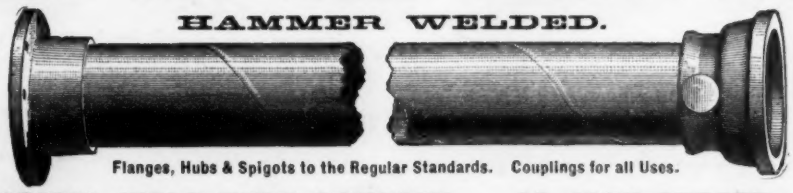

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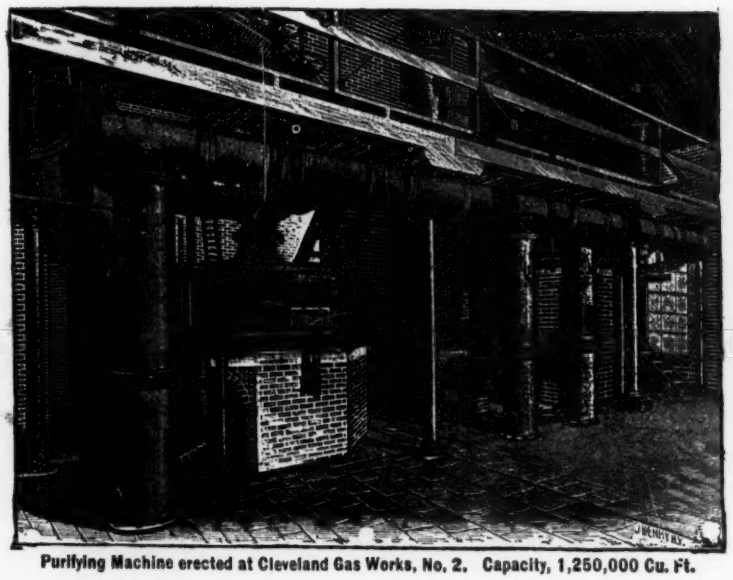

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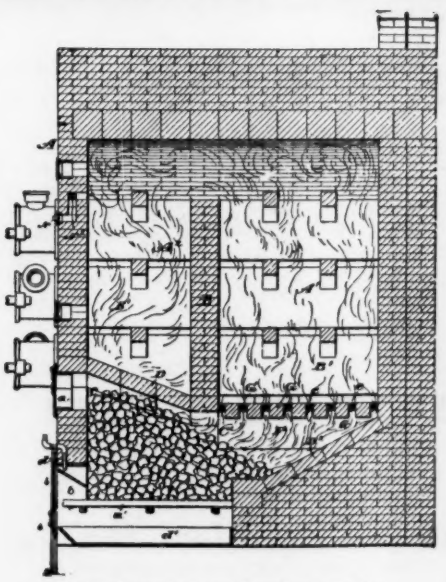

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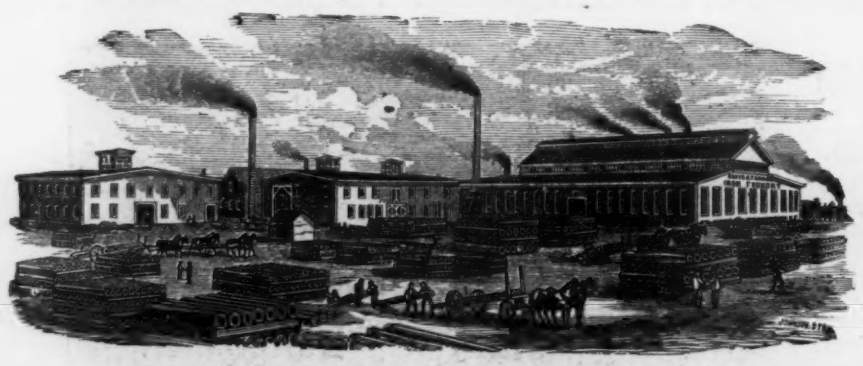

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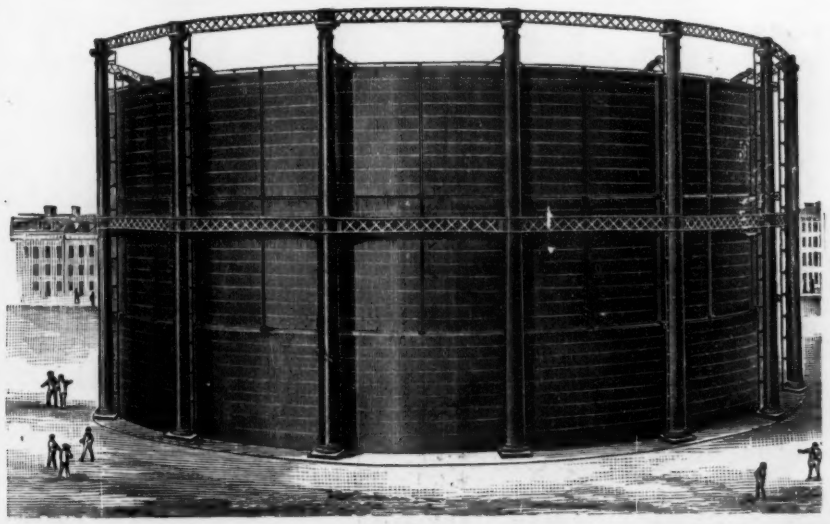

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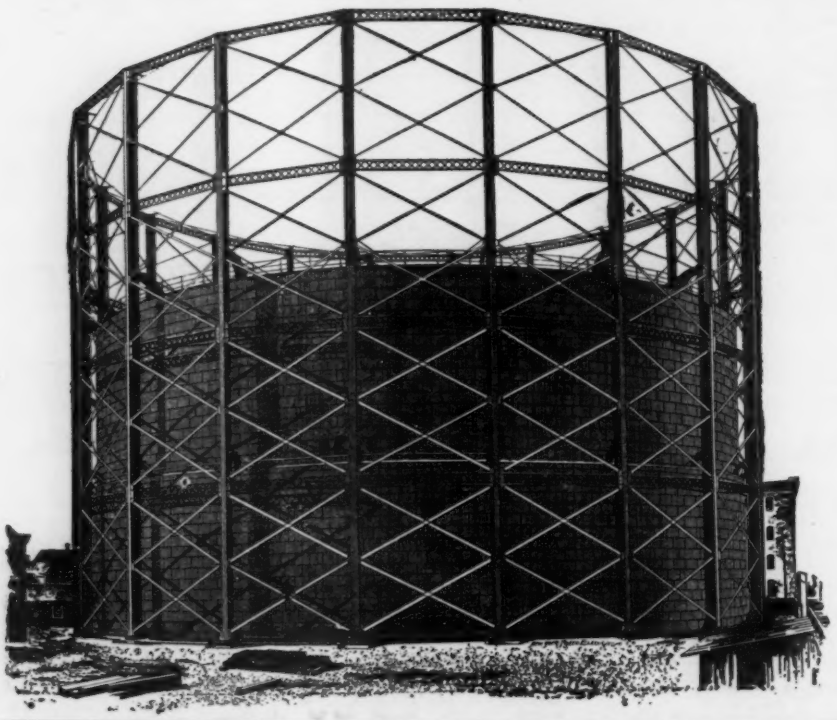

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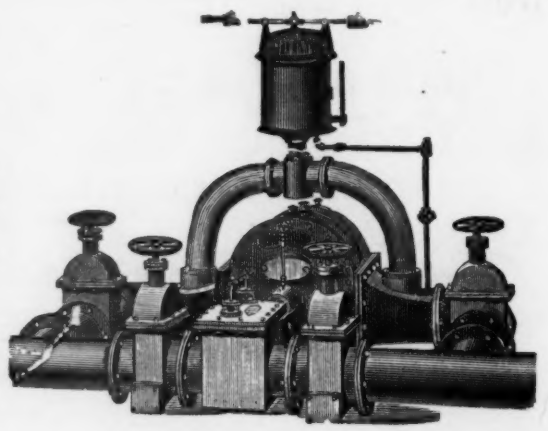

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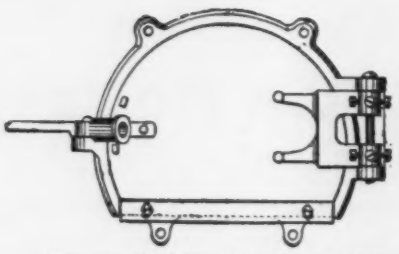

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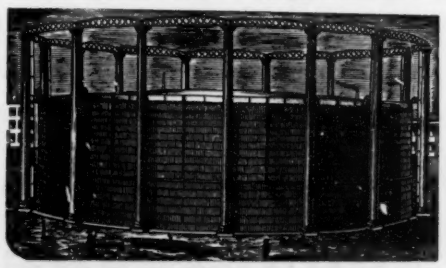

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Saugerties, N. Y.	Rye, N. Y. (2)	Attleboro, Mass.	Bay Shore, L. I.	Woonsocket, R. I.
Clinton, Mass. (Lan. Mills)	Woodstock, Ont.	Santa Cruz, Cal.	Washington, D. C.	Simcoe, Can.
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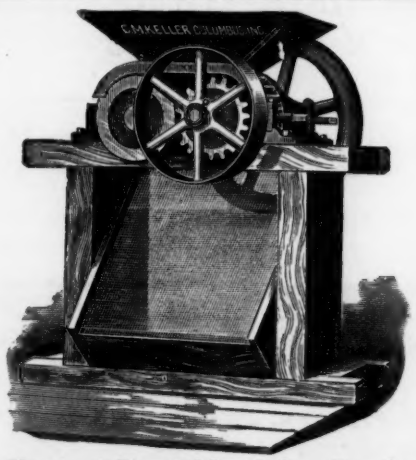

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GAS COOKING STOVE, No. 8 C.

SIZE.

Stove.	Oven.	Roaster.	Top.	Length over Extension Shelves,
37 in. high.	12 in. high.	12 in. high.	24 in. long.	36 in.
20 in. wide.	17½ in. wide.	18 in. wide.	21 in. wide.	
	12 in. deep.	13 in. deep.		

This Stove has four burners on top, and double oven burner.

Consumption of gas with all burners in use, 42 feet per hour, at 1 inch pressure.

The top is made in sections, so that a greater variety of cooking utensils may be used. By lifting out the covers and crosspieces and putting in a suitable forked ring, which is sent with each stove, a wash boiler or other large utensil may be set over two burners. Our **No. 87 GRIDDLE** also fits in the same position. The roasting oven is provided with a cast-iron door.

All Fittings are Nickel-Plated.

GAS COOKING STOVE, No. 7 B.

SIZE.

Stove.	Oven.	Roaster.	Top.	Length over Extension Shelves,
31 in. high.	9½ in. high.	10 in. high.	21 in. long.	32 in.
17 in. wide.	14½ in. wide.	15 in. wide.	16 in. wide.	
	12 in. deep.	13 in. deep.		

This Stove has three boiling burners in the Top or Hot Plate, and one single oven burner.

This cut represents our New Style Cooking Stove. As will be seen, it has an ornamented cast-iron Base and Front, and extension shelves. The Oven Burner, which is atmospheric (unless otherwise ordered), is of an entirely new and improved pattern (patent). The ovens are of greater capacity than those of the old style. The Top, in conjunction with the Outlet Pipe, is designed to carry off all the products of combustion, if desired, but they are also supplied with a loose ring which converts it into an ordinary open top stove.

The consumption of this Stove is 35 cubic feet per hour at 1 inch pressure, with all Burners in use.

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"RADIANT" BOILING STOVE, WITH REGENERATIVE BURNER.

Size, 6¼ inches diameter, 3 inches high. Consumption, 6 feet per hour at 1 in. pressure.

HOT PLATE, No. 111.

Size, 36 in. long, 12 in. wide, with three double burners, 6 taps.

Consumption, with all burners in use, 36 cubic feet per hour, with 1 in. pressure.

¾ in. supply pipe should be used where the pressure is 1 in. or over.